Potential Replacement of Gasoline Vehicles with EV in F&S Fleet

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Executive Summary

This report asseses the feasibility of replacing some of the carpool vehicles with their electric equivalents. *Facilities & Services (F&S)* is the largest administrative unit on the University. There are 1,239 vehicles owned by the University of Illinois Urbana-Champaign, out of which around 500 belong to F&S fleet. *Transportation & Automative Services (TAS)* is responsible for maintaining this fleet. This report analyzes the given data, obtained by TAS and evaluates whether some cars, especially the cars primarily operating within the Champaign County can be converted to Electric Vehicles (EV), in order to follow the objectives laid in the *Illinois Climate Action Plan (iCAP)*. According to 2015 iCAP, the goal for FY20 is for the transportation emissions to return to FY08 baseline levels.

Introduction & Background

The Illinois Climate Action Plan (iCAP) outlines a path for the University of Illinois at Urbana-Champaign to achieve carbon neutrality as soon as possible, and no later than 2050. Based on FY14 data, transportation emissions have increased by 30% since the FY08 baseline [1]. However, the emissions from fleet and commuting are down by 3% and 6%, respectively, the increase in overall emissions is entirely due to air travel. Two of the objectives are by reducing fleet emissions in the next 5 years and developing scenarios for converting the fleet to renewable fuels. This report is related to both of those objectives. The campus fleet includes departmentally owned vehicles, the car and pool truck vehicles, and the heavy equipment pool. The vehicular fleet is primarily cars and vans, while the heavy equipment pool is generally diesel-fueled large construction equipments.

The Facilities & Services fleet is divided into three categories:

- **Car Pool**: contains 220 vehicles including cars, SUV's and minivans. TAS provides fast and convenient full- service car rental for temporary (day or monthly rental) and permanent rentals.

- **Truck Pool**: contains 300 service vehicles for electrical work, cargo-vans and dump trucks.

- **Heavy Equipment Pool**: contains around 24 vehicles. They are large construction vehicles including the waste transfer trucks.

For this report, I am only interested in the *car pool* category because EV equivalents are only available for this vehicle category. The vehicles in *truck pool* have *Sustainable Fleet Certification* (Tier 2 out of 4) from *NAFA Fleet Management Association*. Hence, their emissions are less than the average vehicles for this category.

EV's generally have a range of 80 miles for complete charge, i.e., they can only travel 80 miles and then need to be charged. This poses a big constraint for replacing gasoline powered vehicles because they do not possess such limitations. Further, there are few charging stations for EV's (and hardly any on the highways), hence they are only suitable for vehicles commuting within the Champaign County. Fortunately, this condition is applicable for many departments within the University.

Objective

The primary objective of this report is to analyze whether some vehicles in the carpool fleet can be replaced with EV to achieve goals laid down in 2015 iCAP. This is done by examining the dataset and evaluating parameters like distance traveled, amount of fuel used, type of vehicle and the assigned department.

Methodology

The 'Car pool data.xlsx' workbook was provided by Peter Varney; Director of Transportation and Automotive Services, Facilities & Services. Some data points were entered manually, there are occasional errors in the source data. This workbook had 4 worksheets containing information about permanently assigned vehicles, odometer readings of those vehicles, FY17 fuel purchases and all the vehicles in car pool. Each vehicle had an unique 'Asset' value, which was used as the argument for first summarizing each worksheet and then combining them to summarize the entire dataset to `fleet_data` dataset. As an example, a few values from this dataset are tabulated below:

Summary Fleet Table

Asset	Lease Number	Manufacturer	Model	Year	Car	Department	Status	Amount ($)	Gallons	Fuel Type	Distance
31582-12	200469	FORD	FUSION	2012	SEDAN	FACILITIES AND SERVICES	RENTED	682	341	Unleaded	161
31566-16	NA	FORD	FOCUS	2016	COMPACT SEDAN	NA	RENTED	681	352	Unleaded	NA
31533-12	1803915	FORD	FUSION	2012	SEDAN	FACILITIES AND SERVICES	RENTED	680	341	Unleaded	2355
31878-06	2401440	FORD	E35Y	2006	15-PASS VAN	FACILITIES AND SERVICES	RENTED	672	349	Diesel	2691
31438-17	2004170	FORD	FUSION	2017	SEDAN	DIVISION OF SPECIALIZED CARE FOR CHILDREN	RENTED	668	309	Unleaded	11672
31505-14	400524	FORD	FUSION	2014	SEDAN	OBFS - SAVP BUS & FINANCE	RENTED	665	353	Unleaded	3023
31593-13	400442	CHEVROLET	IMPALA	2013	SEDAN	UNIV OFC FOR HUMAN RESOURCES	ACTIVE	663	324	Unleaded	1386
31439-12	1403024	FORD	FUSION	2012	SEDAN	FACILITIES AND SERVICES	TRADED	658	282	Unleaded	1065
31547-11	1403003	FORD	FUSION	2011	SEDAN	FACILITIES AND SERVICES	ACTIVE	658	335	Unleaded	682
31442-17	1403073	FORD	FUSION	2017	SEDAN	DIVISION OF SPECIALIZED CARE FOR CHILDREN	RENTED	650	305	Unleaded	8054
31405-11	NA	FORD	FUSION	2011	SEDAN	NA	DISPOSED	649	331	Unleaded	NA

The *NA* values indicate that data was missing from the source because that vehicle was not permanently assigned. For summarizing and plotting, the NA values were neglected. Also, the original had return and release odometer readings, which were subtracted to obtain the distance traveled by the vehicle. Since these readings were reported once a month, average distance is not a good measure to evaluate this. Hence, the 'Distance' column contains the total distance recorded by that vehicle for the entire available data.

The output below summarizes `fleet_data` on the basis of 'Status' column:

```
## # A tibble: 5 x 2
##         Status total
##         <fctr> <int>
## 1       RENTED   145
## 2       ACTIVE    72
## 3     DISPOSED    19
## 4       TRADED    10
## 5  INOPERATIVE     3
```

The disposed, traded and inoperative vehicles are neglected for further analysis because I am only interested in evaluating whether the currently operating vehicles can be replaced.

The output below summarizes `fleet_data` on the basis of 'Fuel Type' column:

```
## # A tibble: 2 x 2
##   Fuel.Type total
##      <fctr> <int>
## 1  Unleaded   243
## 2    Diesel     6
```

Since there are 243 entries for Unleaded and only 6 for diesel, I can assume the entire dataset to use unleaded fuel. Further, I noticed that some data entries had the same vehicle for both unleaded and diesel (which is not possible because a vehicle can only can use a particular kind of fuel), hence my assumption that the entire data is unleaded is acceptable.

Results and Discussion

Potential Vehicle Replacement

Out of all the vehicles in the `fleet_data` dataset, only Sedan and Compact Sedan have their EV equivalents available in the market.

```
## [1] "15-PASS VAN"   "COMPACT SEDAN" "FULL SIZE VAN" "MINI VAN"
## [5] "SEDAN"         "SUV 4X2"       "SUV 4X4"       "WORK TRUCK"
```

The plot below shows the distribution of Compact Sedan and Sedan for various manufacturers for only Active and Rented status in increasing order (from top to bottom):

Distribution of Compact Sedan & Sedan across Manufacturer
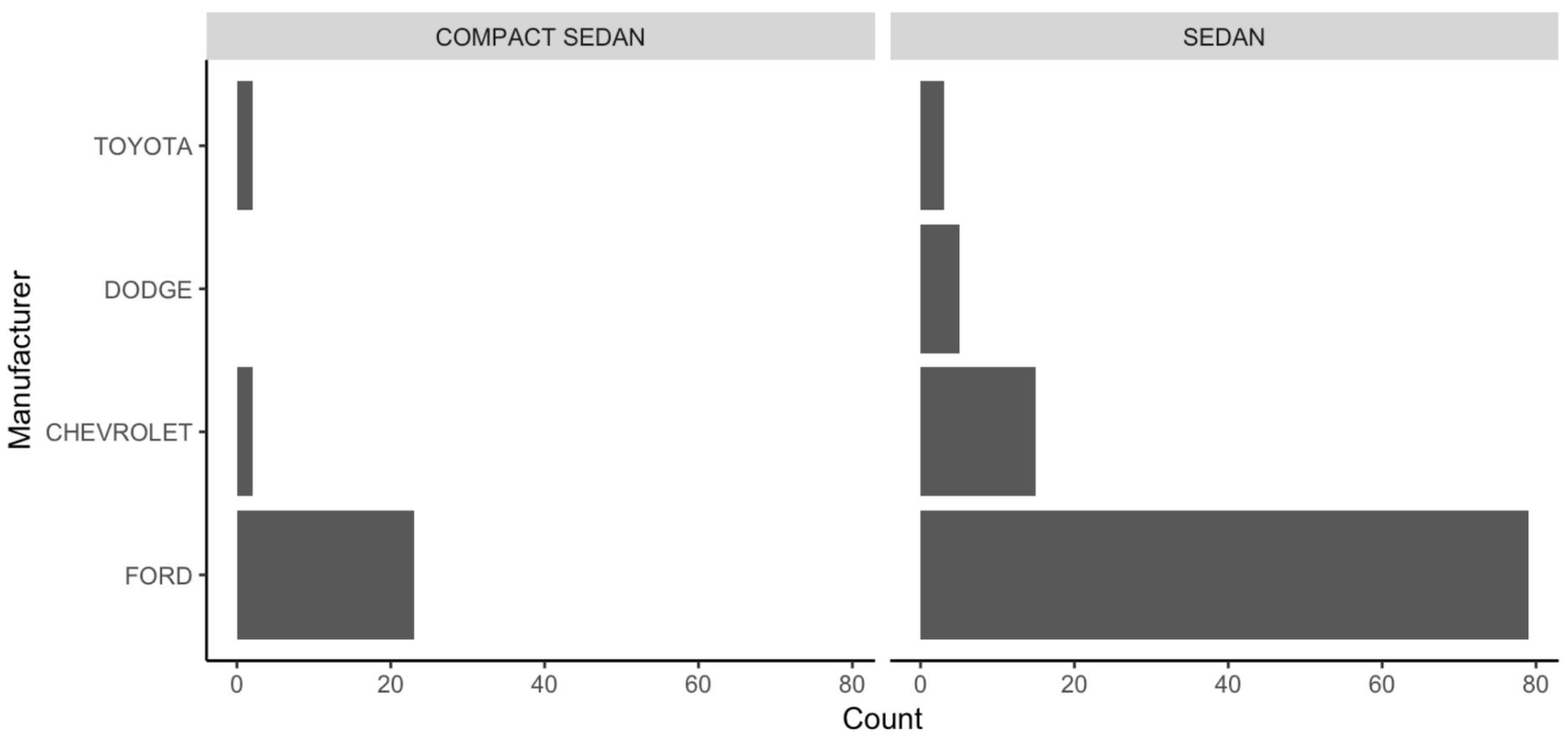
The `fleet_data` is subset to create `ev_fleet_data`, which contains all leased Compact Sedan & Sedan currently owned by the University (i.e. whose status is either active or rented). The first fifteen values of `ev_fleet_data` are tabulated below:

Potential Compact Sedan & Sedan Replacements

Asset	Lease Number	Manufacturer	Model	Car	Department	Status	Amount ($)	Gallons	Distance	Dist. Category
31431-15	200476	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	RENTED	504	263	10	Under 1500
31512-12	400926	CHEVROLET	IMPALA	SEDAN	FACILITIES AND SERVICES	RENTED	605	322	14	Under 1500
31503-17	200477	FORD	FOCUS	COMPACT SEDAN	DIVISION OF RESEARCH	RENTED	37	20	15	Under 1500

					SAFETY					
31582-12	200469	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	RENTED	682	341	161	Under 1500
31580-12	601380	CHEVROLET	IMPALA	SEDAN	FACILITIES AND SERVICES	RENTED	616	329	261	Under 1500
31446-14	1802421	CHEVROLET	IMPALA	SEDAN	UNIVERSITY COUNSEL	ACTIVE	501	255	294	Under 1500
31592-17	200474	FORD	FUSION	SEDAN	STATE FARM CENTER	RENTED	72	34	304	Under 1500
31444-11	801820	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	RENTED	812	405	308	Under 1500
31544-12	200468	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	RENTED	716	363	395	Under 1500
31410-17	601374	FORD	FUSION	SEDAN	PRINCIPAL'S SCHOLARS PGM	RENTED	27	14	447	Under 1500
31543-16	801764	FORD	FOCUS	COMPACT SEDAN	DIVISION OF RESEARCH SAFETY	RENTED	562	296	613	Under 1500
31547-11	1403003	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	ACTIVE	658	335	682	Under 1500
31555-11	2404272	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	RENTED	89	47	823	Under 1500
31437-11	400928	FORD	FUSION	SEDAN	FACILITIES AND SERVICES	RENTED	1302	670	837	Under 1500
31539-12	2204510	CHEVROLET	IMPALA	SEDAN	FACILITIES AND SERVICES	RENTED	155	80	1029	Under 1500

Distance travelled distribution

Furthermore, a new column 'Dist. Category' was created, which splits the dataset into 4 categories according to the total distance traveled by that vehicle. This column is vital for the analysis because it identifies the vehicles leased by the university department having traveled shorter distance (less than 1500 miles for the available time frame). Thus, such vehicles are assumed to be used only within Champaign County and are suitable to be replaced by EV.


Distribution of each vehicle over distance travelled
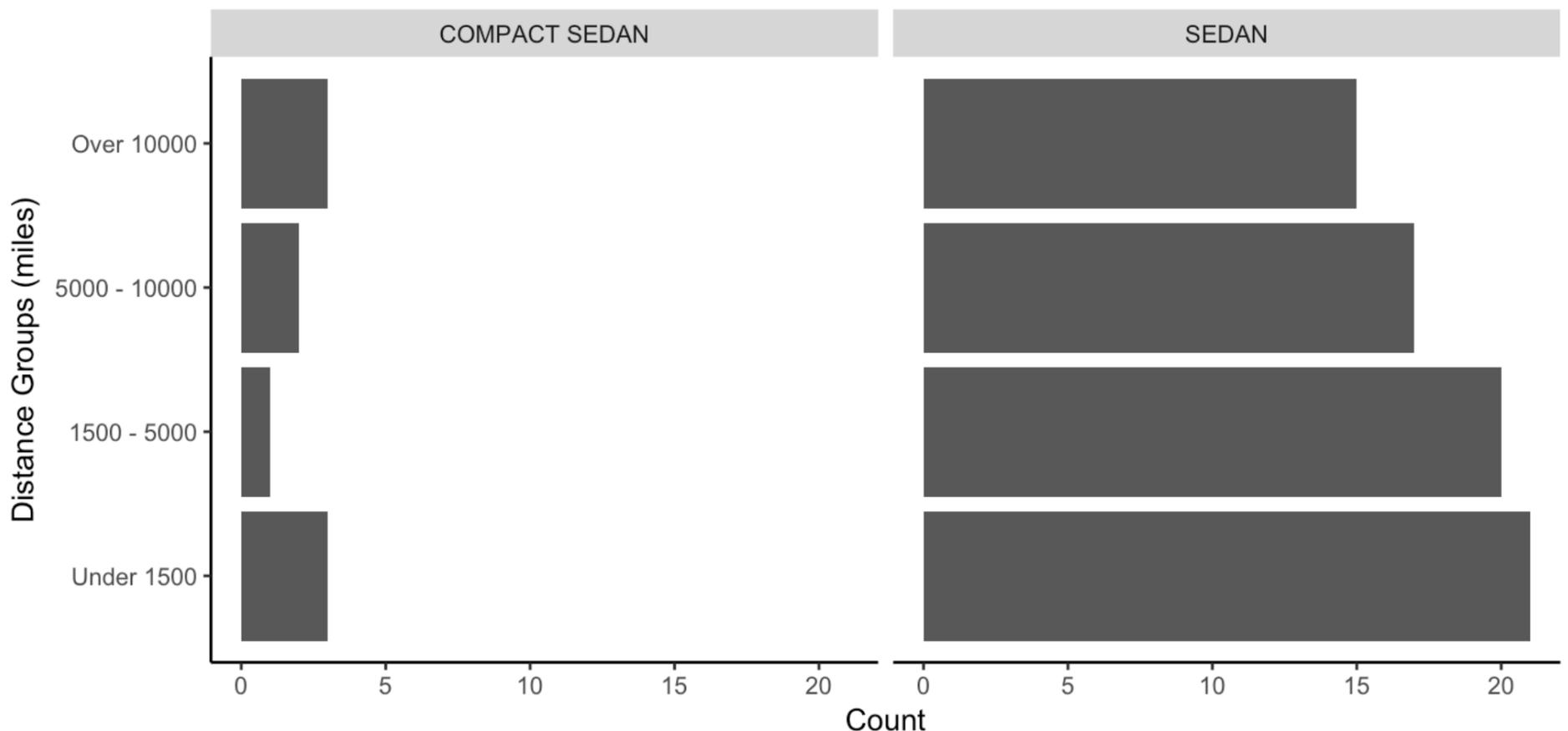
This plot clearly shows that there are over 20 Sedan (mostly Manufactured by Ford) that have traveled less than 1500 miles.

It is interesting to demonstrate the total distance traveled by each vehicle from the `fleet_data` data set.

Distribution of total distance travelled by each car category
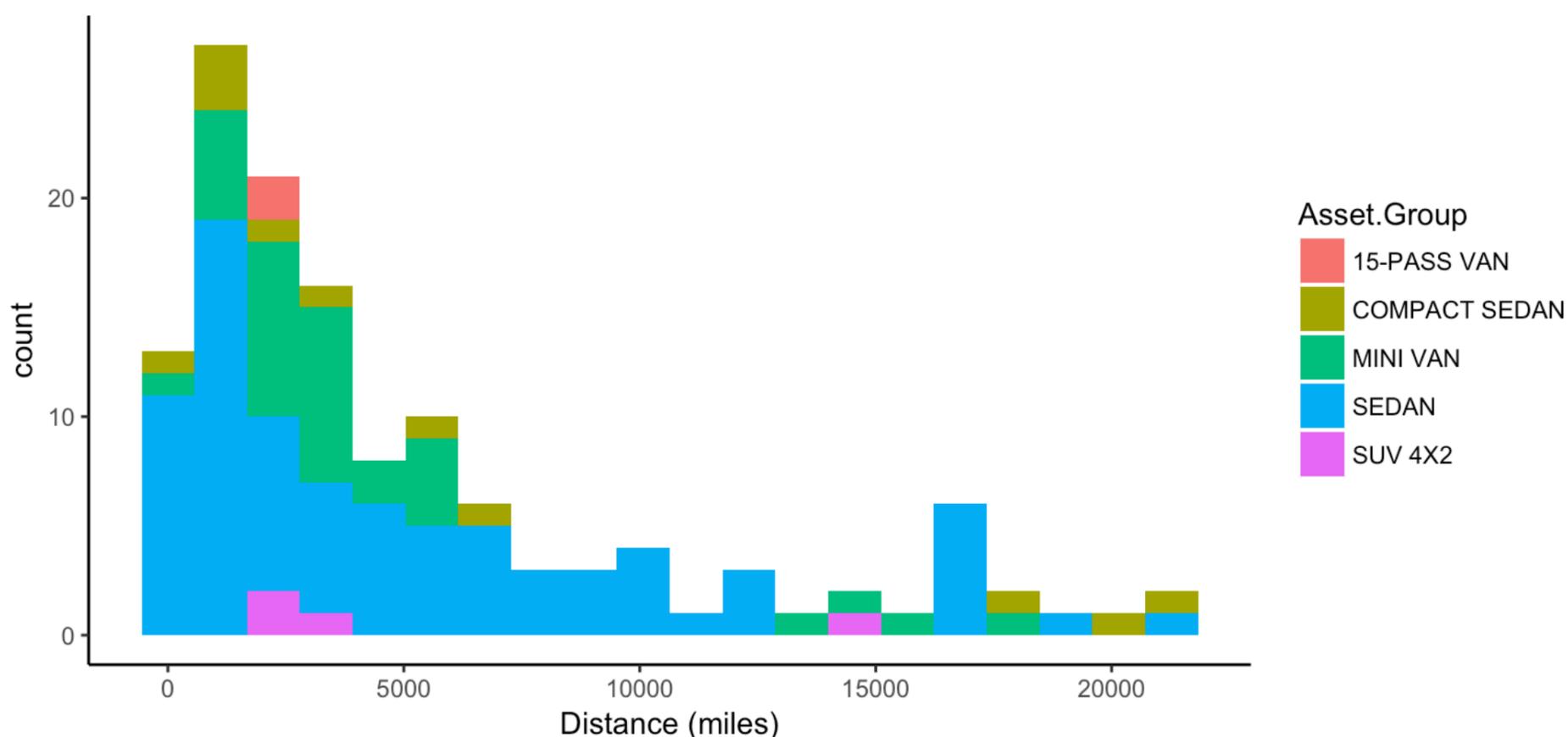
Long distances have only been recorded for Compact Sedans, Sedans and few Mini Vans. Since Compact Sedans and Sedans are traded roughly after a period of 6 years or 80,000 miles, this histogram identifies many such vehicles who have covered a large distance.

Conclusions

Not surprisingly, the initial cost associated with replacing traditional vehicles with their electric counterparts would be higher, but such an investment is beneficial for a longer time period. This practice would further lower emissions from the fleet and strive towards achieving the objectives laid out in the 2015 iCAP. Another interesting observation was that clients prefer electric vehicles because of modern features offered (for instance, Bluetooth connection etc.) with the electric cars. Most importantly, since EV are restricted to shorter distance, it makes them ideal for our University campus. Lastly, talking and convincing the customers renting/leasing these vehicles will be equally important. Another factor that can be looked is how many passengers are there in a car at any given point of time. Since the proportion of Sedans are much higher than Compact Sedans, but I suspect that there is only a single passenger most of the times. Therefore, I suggest the proportion of Compact Sedans should be increased too.

Acknowledgements

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References

1. 2015 Illinois Action Climate Plan (https://icap.sustainability.illinois.edu)

The `ev_fleet_data` and `fleet_data` datasets are available as excel files.