

Background

In 2017, the Electrification Coalition (EC) began working with Sawatch Group to provide analyses of fleet vehicle suitability for transition to electric vehicles (EVs) and pilot the use of ezEV analytics platform to perform the analyses. In summer 2017, the City of Atlanta engaged with the EC about the opportunity to conduct an analysis of 50 vehicles for transition to EVs as part of the city's overall goal of transitioning 20% of the municipal fleet to electric vehicles which is approximately 600 EVs. This document summarizes the methodology adopted to complete that analysis and a description of the outputs and recommendations generated.

ezEV Methodology

Telematics Data

The City of Atlanta had already contracted with a telematics provider—Verizon Networkfleet—to provide telematics data across fleet vehicles in the Department of Watershed Management. Through their ezEV-Light software, Sawatch Group is able to provide analysis of EV suitability using any telematics provider's data. This analysis uses vehicle performance, routing, and location data from Networkfleet to: (1) inform the suitability of each vehicle for transition to an EV; (2) identify the necessary electric vehicle supply equipment (EVSE) (aka charging infrastructure) needed to match the driving needs of these vehicles should they be transitioned to EVs; and (3) provide guidance on EV Total Cost of Ownership (TCO), return on investment (ROI), and potential cost savings. There are 50 vehicles for which Sawatch accessed Networkfleet data; the time period covered by this analysis: August 1, 2017 through October 31, 2017.

Individual Vehicle Compatibility

The ezEV fleet assessment translates drive cycles and driving behavior for individual fleet vehicles into an EV Suitability score for each vehicle assessed. This methodology explains vehicle use and driving style in the context of impact on vehicle performance as if the vehicle operator were driving an EV, doing so across four metrics contributing to an overall EV Suitability score. Each metric is based on a score of 1–100, but lower scores do not necessarily indicate that an EV could not work in a particular application or duty cycle. Instead, lower scores suggest that modifying driving habits and/or identifying where midday charging could occur to complete each day's driving needs may be necessary.

- **Overall Score:** Considering a combination of the categories below, how well each vehicle is suited for transition to an EV.
- **Confidence:** The degree to which an available data set constitutes a representative sample of driving.
- **Energy Use:** How often a vehicle could rely on a single daily charge—eliminating the need for midday charging and assuming that each day the vehicle would start with a fully charged battery.
- **Speed:** The amount of time driven at lower speeds—frequent travel at highway speeds can reduce the range of a battery electric vehicle (BEV) or the all-electric range of a plug-in hybrid electric vehicle (PHEV).

- **Efficiency:** The impact of driving style on a vehicle’s efficiency—how aggressively an EV is driven affects the vehicle’s actual miles per kilowatt hour (mi/kWh) in the same way that driving style affects miles per gallon (MPG) in an internal combustion engine (ICE) vehicle.

The scores can then be used to provide a degree of certainty in a fleet manager’s decision to replace a conventional vehicle with an electric drive vehicle. Electric drive vehicles effectively come in two varieties, BEVs and PHEVs. They differ primarily in the form of fuel or energy they store on board and can access when they are driving, and as a result differ in the distance they can travel when fully fueled. BEVs have energy in the form of electricity, stored on board the vehicle, and the vehicle is limited as to the range it can travel on a single charge depending on the size or capacity of the battery in which the fuel, as electricity, is stored. Limited range can lead to “range anxiety,” or driver concern about running out of energy/fuel before returning to the vehicle’s garage location. PHEVs have both a battery, typically smaller than a BEV’s battery, and a conventional ICE that runs on liquid gasoline fuel. As a result, PHEVs have a considerably longer range, and PHEV drivers are not subject to “range anxiety.”

The ezEV analytics use specific makes and models of EVs to generate the EV Suitability Scores. Each vehicle has a “total” and “usable” battery capacity¹ used in calculating score. Atlanta indicated interest in the following makes and models of EVs: Ford Focus BEV, Chevrolet Bolt BEV, Nissan Leaf BEV, and the Chevrolet Volt PHEV. Accordingly, this ezEV analysis employs operational metrics specific to these vehicles throughout the analysis (Table 1). All vehicles are assumed to charge at a rate of 4.15 kW using Level 2 EVSE.²

Table 1. Study Vehicle Characteristics

2018 Model Year Vehicles	MSRP	Total Battery Capacity	Usable Battery Capacity	Estimated All-Electric Range
Ford Focus BEV	\$29,120	33.5 kWh	28.5 kWh	115 miles
Chevrolet Bolt BEV	\$37,495	60 kWh	51 kWh	238 miles
Nissan Leaf BEV	\$32,900	40 kWh	34 kWh	150 miles
Chevrolet Volt PHEV	\$34,095	18.4 kWh	15.6 kWh	53 miles

Electric Vehicle Supply Equipment

An inherent benefit of telematics is the collection of location data. These data are not only useful to understand where a vehicle travels, but also to understand where vehicles regularly park, especially overnight, when opportunities for charging can be maximized. The data will allow Atlanta to make an informed decision about fleet vehicle use of existing EVSE at city facilities and the number of additional Level 2 EVSE units that must be installed to support new EVs. By optimizing the number of Level 2 chargers installed, it is possible to reduce the amount of infrastructure needed and, as a result, reduce infrastructure and overall project costs.

¹ Electric vehicle batteries are rated in terms of “battery capacity” or the total amount of energy the battery can store. The amount of energy a vehicle can use in real-world driving conditions is generally 80%–90% of the battery’s total capacity.

² Level 2 EVSE refers to equipment that will charge a vehicle through a 240-volt (V) electrical service, Level 1 charging refers to a 120-V service or outlet, and DC fast charging requires 480-V service. Additional information on EVSE definitions is available at https://www.afdc.energy.gov/fuels/electricity_infrastructure.html.

To evaluate infrastructure needs, ezEV characterizes each trip by duration, estimated electricity use, and starting and ending location. The same metrics are calculated and compiled for each individual day that a vehicle operates. Overnight parking locations and durations are a focus, to estimate the time that would be needed to fully recharge each vehicle after a day's worth of driving.

Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions savings are estimated based on the grid mix of electricity production in Georgia.³ This level of granularity provides more accurate estimates of GHG emission savings due to EV use. It is common to use regional averages for such estimates, which aggregate grid mix averages across eight regional entities that constitute the North American Electrical Reliability Corporation. Atlanta is part of the SERC Reliability Corporation. Electricity production data at a more granular level than the state level (e.g., at the county or municipal level) are not available at this time.

The GHG emissions rate (grams per kilowatt-hour) from Georgia's grid mix ranks approximately 23rd out of 50 states with a mix split fairly evenly between natural gas (35 percent), coal (33 percent) and nuclear (28 percent). As Georgia continues to add new sources of renewable energy to its grid mix, this number only stands to improve.

Impacts of Driver Behavior

The driving style and behavior of individual fleet vehicle drivers can have a noticeable impact on fuel consumption and vehicle efficiency. As with an ICE vehicle, the efficiency of an EV—and therefore the overall range of a battery charge—is affected by how drivers operate the vehicle. Aggressive starts and stops, as well as excessive speeding, reduce efficiency. Studies by National Renewable Energy Laboratory estimate that improving driver behavior could reduce fuel consumption by 10 percent, and up to 20 percent for the most aggressive drivers.⁴ Translated to an EV, these same improvements would extend the range of a battery charge significantly. The analysis in this report accounts for these behaviors using an Efficiency score factored into the overall EV Suitability score.⁵

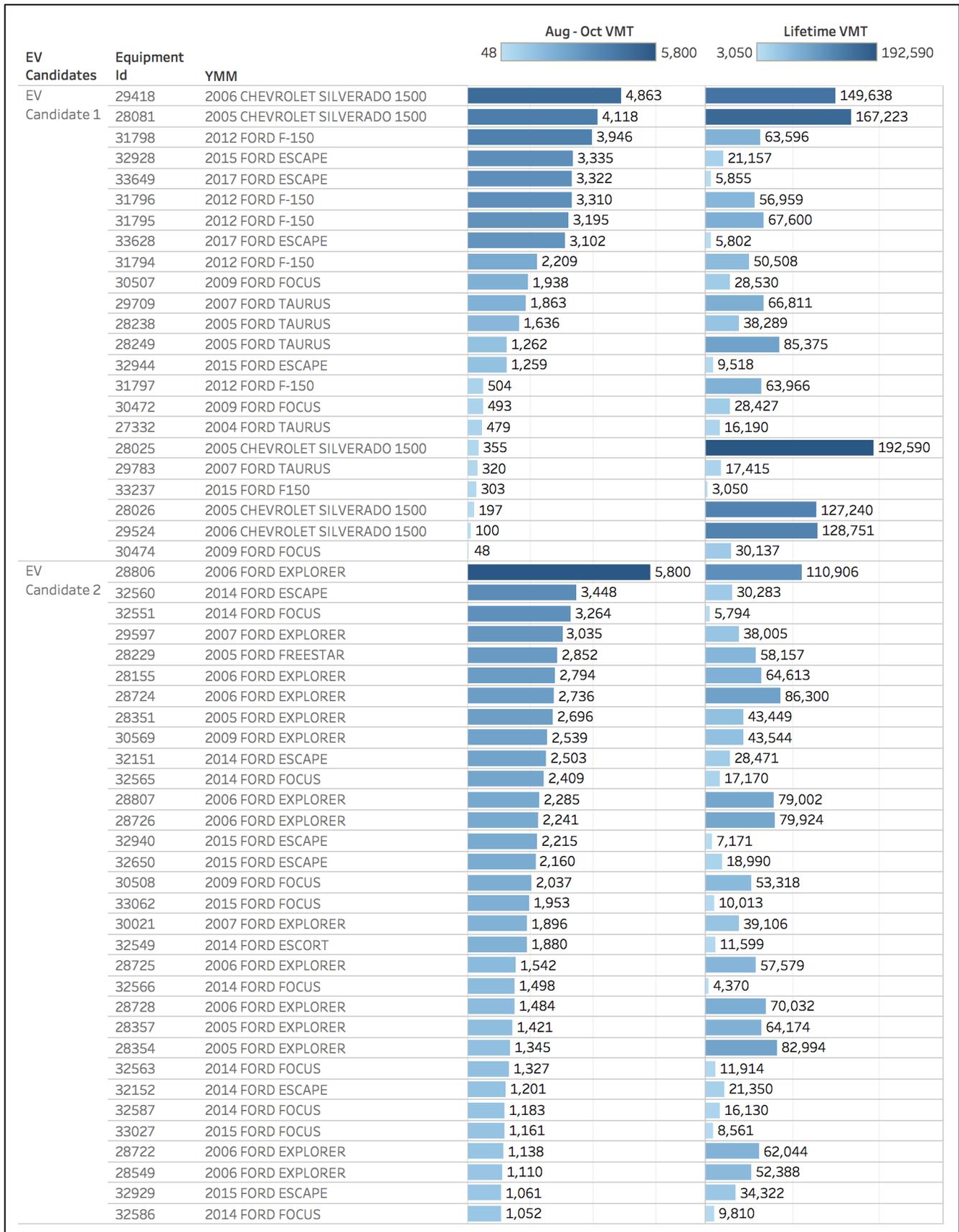
³ Source: U.S. Environmental Protection Agency (EPA) eGRID 2012 data

(https://www.epa.gov/sites/production/files/2015-10/documents/egrid2012_summarytables_0.pdf).

⁴ Source: Alternative Fuels Data Center (http://www.afdc.energy.gov/conserve/driving_behavior.html).

⁵ The value of this score is heavily influenced by the granularity of telematics data, because aggressive driving behaviors are easier to detect with more granular data. For example, Sawatch Group's ezEV application detects rapid changes in movement using a smartphone's accelerometer in milliseconds, logging and transmitting those instances every 4 seconds. Traditional telematics typically collect and transmit data over longer intervals, usually 1 to 2 minutes, and therefore miss these more rapid changes in movement.

Figure 1: VMT during the data collection period and lifetime, by vehicle



Summary of Results

General Fleet Characteristics

[Figure 1](#) summarizes VMT by vehicle for both the duration in which data was collected and analyzed for this report as well as over the lifetime of each vehicle. There are 55 total vehicles included in the analysis.

Vehicles are grouped into two sets of “EV Candidates”. The first group of 23 vehicles was sources from the initial list of vehicles submitted by Atlanta’s fleet management team. See [Table 1](#). That list of 51 vehicles included 28 vehicles that did not record any Networkfleet telemetry from August 1, 2017 through October 31, 2017. These vehicles are listed in [Figure 2](#). Four of the remaining 23 vehicles did not record enough miles over this timeframe to generate a representative sample of driving and therefore their EV Suitability Scores are not reliable.

To supplement the original list of vehicles and get to a total of 50 vehicles included in the overall analysis, we selected 32 additional vehicles based on the following criteria: drove at least 1,000 miles during the 76 business days covered by this dataset, are at least two years old, and are among one of the following vehicle models: Ford Escape, Ford Explorer, Ford Focus, Ford Taurus, Ford Freestar, or Chevy Malibu. See [Table 2](#). There are another 25 vehicles that meet these criteria but had less than 1,000 miles of telematics data. For the most part, pick-up trucks were not included in this analysis unless they were part of the first group of EV candidates. The Watershed department has 44 pickups with less than 1,000 miles during this time period and 79 pickups with more than 1,000 miles.

Vehicle selection and analyses occurred across two complementary datasets: Assetworks inventory management system and Networkfleet telematics. Assetworks lists 1,238 pieces of equipment for the Watershed Department: 692 to Waste Water and 546 to Drinking Water. There are 421 vehicles that appear in the Networkfleet database. There are 324 vehicles present in both databases. During the 76 business days’ worth of data collected, the following sets of low-utilization vehicles appeared:

- 30 logged less than 100 total miles. These vehicles averaged six days of use (8 percent) and 20.9 miles, or 3.9 miles per day of use. See [Figure 3](#).
- 89 logged more than 100 but less than 1,000 total miles. These vehicles averaged 32 days of use (32 percent—ranging from a low of 4 days to a high of 71) and 478 miles, or 16.7 miles per day of use. See [Figure 4](#).

There were also 97 VINs in the Networkfleet data that do not show up in the Assetworks data:

- 47 of these logged more than one mile.
- 8 of these logged less than one mile.
- 41 of these logged zero miles.

EV Suitability Scores

Table 1: First Round of EV Candidates identified by the City of Atlanta.

Vehicle ID	Overall Score	EV Recommendation	Needed EVSE Location
Sedans			
27332	74	Ford Focus BEV	Has: SNAFC
28238	92	Ford Focus BEV	South River WPC
28249	84	Nissan Leaf	Stonewall Substation
29709	77	Chevy Bolt	South River WPC
30472	89	Ford Focus BEV	Watershed HQ
30507	90	Ford Focus BEV	Multiple Locations
32928*	83	Nissan Leaf	Clayton Water Plant
32944	87	Nissan Leaf	Watershed HQ
33628*	88	Nissan Leaf	Multiple Locations
33649*	85	Ford Focus BEV	Clayton Water Plant
Pickup Trucks (Silverado & F-150)			
28025^	81	Ford Focus or PHEV Pickup	Watershed HQ
28081	69	Chevy Bolt or PHEV Pickup	Watershed HQ
29418	86	Ford Focus or PHEV Pickup	Watershed HQ
31794	82	Nissan Leaf or PHEV Pickup	Clayton Water Plant
31795	80	Chevy Bolt or PHEV Pickup	Clayton Water Plant
31796	88	Nissan Leaf or PHEV Pickup	Has: SNAFC
31797^+	72	PHEV Pickup	Clayton Water Plant
31798	78	Nissan Leaf or PHEV Pickup	Clayton Water Plant
33237^+	75	Ford Focus or PHEV Pickup	Watershed HQ
Underutilized - Not enough data for an EV recommendation			
30474			
29524			
28026			
29783			

*High mileage vehicle with > 1k mi/mo.

Table 2: Second Round of EV Candidates identified by the Electrification Coalition.

Vehicle ID	Overall Score	EV Recommendation	Needed EVSE Location
Sedans			
30508	89	Chevy Bolt	Watershed HQ
32549	88	Chevy Bolt	JW Sewer Const. & Maint.
32551	78	Chevy Bolt	South River WPC
32563	89	Ford Focus BEV	Watershed HQ
32565**	88	Ford Focus BEV	Watershed HQ
32566	86	Ford Focus BEV	Multiple Locations
32586	84	Ford Focus BEV	South River WPC
32587	77	Ford Focus BEV	Watershed HQ
33027	90	Nissan Leaf	Watershed HQ
33062	79	Chevy Bolt	Pipeyard Maint. & Storage Facility
Ford Freestar Minivan			
28229	83	Ford Focus BEV	Utoy Creek WRC
Ford Escape SUV			
32151	82	Ford Focus BEV	South River WPC
32152**	81	Nissan Leaf	JW Sewer Const. & Maint.
32560**	89	Ford Focus BEV	JW Sewer Const. & Maint.
32650***	90	Chevy Volt	City Hall
32929^**	72	Ford Focus BEV	Watershed HQ
32940	89	Nissan Leaf	Has: SNAFC
Ford Explorer SUV			
28155	88	Ford Focus BEV	South River WPC
28352	87	Ford Focus BEV	South River WPC
28354	91	Ford Focus BEV	Has: SNAFC
28357	87	Ford Focus BEV	RM Clayton Water Plant
28549	83	Ford Focus BEV	South River WPC
28722	82	Ford Focus BEV	Stonewall Tank and Substation
28724	88	Ford Focus BEV	South River WPC
28725	91	Ford Focus BEV	Has: SNAFC
28726	88	Ford Focus BEV	South River WPC
28728	86	Ford Focus BEV	South River WPC
28806**	79	Chevy Bolt	Residential
28807	88	Chevy Bolt	JW Sewer Const. & Maint.
29597	80	Ford Focus BEV	Stonewall Tank and Substation
30021	90	Ford Focus BEV	Has: SNAFC
30569	79	Ford Focus BEV	Has: SNAFC

**Vehicle frequently parks overnight at a residential location

***Vehicle parks near EVSE, move from the parking lot to city call every morning around 7:20 AM and stay there for approximately 1:20. They would not have time to fully charge a BEV unless it begins parking at one of the available EVSE nearby for overnight charging.

^Low-utilization

†Low confidence score.

Appendix

Figure 2: Vehicles with and without telemetry among the first round of EV candidates.

Department	Equipment Id	VIN	YMM	Date - First Trip	Date - Last Trip	VMT
Watershed - Drinking Water	29418	1GCEC19Z16Z273618	2006 CHEVROLET SILVERADO 1500	8/3/2017	11/10/2017	4,863
	28081	1GCEC19V15Z252926	2005 CHEVROLET SILVERADO 1500	7/31/2017	11/2/2017	4,118
	31798	1FTNF1CFXCKD61965	2012 FORD F-150	7/31/2017	11/9/2017	3,946
	32928	1FMCU9GX0FUC65684	2015 FORD ESCAPE	8/1/2017	11/9/2017	3,335
	33649	1FMCU9GD7HUC54447	2017 FORD ESCAPE	8/7/2017	11/9/2017	3,322
	31796	1FTNF1CF5CKD61968	2012 FORD F-150	7/31/2017	11/9/2017	3,310
	31795	1FTNF1CF3CKD61967	2012 FORD F-150	7/31/2017	11/9/2017	3,195
	33628	1FMCU9GD9HUC54448	2017 FORD ESCAPE	8/1/2017	11/10/2017	3,102
	31794	1FTNF1CF1CKD61966	2012 FORD F-150	7/31/2017	11/8/2017	2,209
	30507	1FAHP35N09W116013	2009 FORD FOCUS	8/15/2017	11/9/2017	1,938
	29709	1FAFP53U67A186140	2007 FORD TAURUS	8/1/2017	11/13/2017	1,863
	28238	1FAFP53U65A283545	2005 FORD TAURUS	8/1/2017	11/9/2017	1,636
	28249	1FAFP53U85A291243	2005 FORD TAURUS	9/27/2017	11/8/2017	1,262
	32944	1FMCU9GXXFUC65689	2015 FORD ESCAPE	7/31/2017	11/9/2017	1,259
	31797	1FTNF1CF7CKD61969	2012 FORD F-150	8/8/2017	10/24/2017	504
	30472	1FAHP35N49W116015	2009 FORD FOCUS	8/1/2017	11/9/2017	493
	27332	1FAFP52U24A196192	2004 FORD TAURUS	8/1/2017	11/9/2017	479
	28025	1GCEC19V15Z253378	2005 CHEVROLET SILVERADO 1500	7/31/2017	11/7/2017	355
	29783	1FAFP53U07A186201	2007 FORD TAURUS	8/11/2017	11/8/2017	320
	33237	1FTMF1CP5FKE52652	2015 FORD F150	8/1/2017	11/8/2017	303
	28026	1GCEC19V55Z251021	2005 CHEVROLET SILVERADO 1500	9/14/2017	11/6/2017	197
	29524	1GCEC19Z26Z277158	2006 CHEVROLET SILVERADO 1500	10/30/2017	11/13/2017	100
	30474	1FAHP35N69W116016	2009 FORD FOCUS	9/20/2017	10/4/2017	48
	30473	1FAHP35NX9W116018	Null	Null	Null	
	30471	1FAHP35N89W116017	Null	Null	Null	
	29782	1FAFP53U27A186202	Null	Null	Null	
	29781	1FAFP53U47A186203	Null	Null	Null	
	29780	1FAFP53U97A186200	Null	Null	Null	
	29708	1FAFP53U87A186141	Null	Null	Null	
	29706	1FAFP53U07A186148	Null	Null	Null	
	29507	1GCEC19Z56Z272813	Null	Null	Null	
	29420	1GCEC19Z06Z273626	Null	Null	Null	
	28778	1FAFP53266A220400	Null	Null	Null	
28688	1FAFP53286A216378	Null	Null	Null		
28245	1FAFP53U55A291247	Null	Null	Null		
28243	1FAFP53U05A291253	Null	Null	Null		
28236	1FAFP53U15A283551	Null	Null	Null		
28234	1FAFP53U35A283549	Null	Null	Null		
28218	1FAFP53U75A291251	Null	Null	Null		
27926	1FTYR10U95PA58320	Null	Null	Null		
27803	1FTYR10U25PA12411	Null	Null	Null		
27328	1FAFP52U44A196193	Null	Null	Null		
27321	1FTNX21PX4EC86778	Null	Null	Null		
27154	1FAFP52U44A139685	Null	Null	Null		
27080	1GCCS14X138271921	Null	Null	Null		
25747	1FAFP5229YA271670	Null	Null	Null		
Watershed - Waste Water	28248	1FAFP53UX5A291244	Null	Null	Null	
	28237	1FAFP53U35A283552	Null	Null	Null	
	28217	1FAFP53U55A291250	Null	Null	Null	
	28013	1GCEC19V85Z253975	Null	Null	Null	
	27769	1FAFP53U75A134013	Null	Null	Null	

0K 2K 4K 6K
VMT

Figure 3: Vehicles with less than 100 miles of telemetry from 8/1 – 10/31.

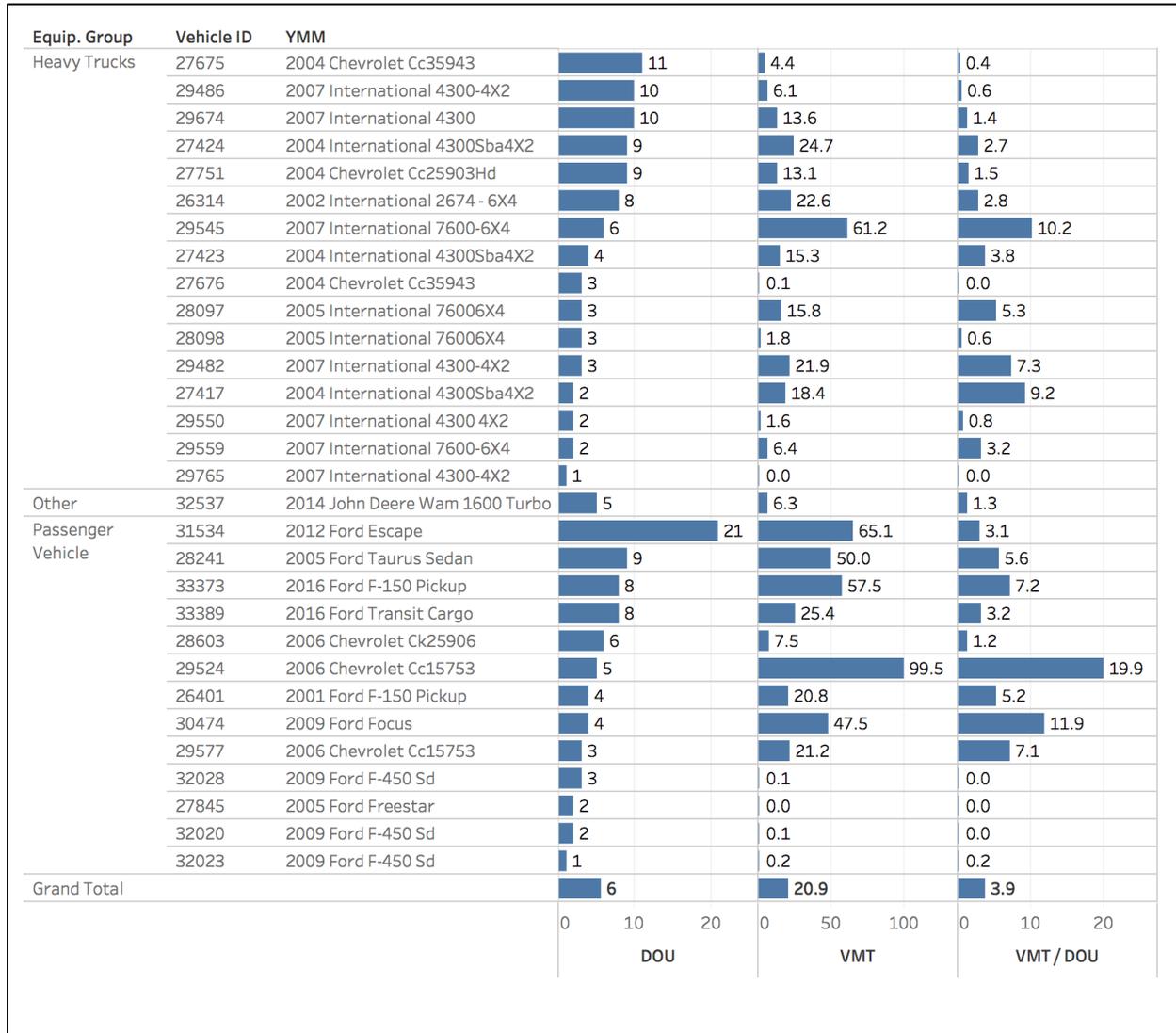


Figure 4: Passenger vehicles with 100 – 1,000 miles of telemetry from 8/1 – 10/31.

