Table of Contents

Overview

This Report analyzes rideshare data collected from an all-electric 2024 Chevy Equinox. Data was recorded for a total duration of 60 minutes and 33 seconds. A total distance of 20.4 miles were traveled. A gas vs battery cost analysis is provided. After that, an analysis of velocity and acceleration's effect on energy usage is shared.

The data recorded includes time, speed, and power. The power data collected did not include the power regenerated while slowing down. However, the regeneration and actual power consumption was obtained via the vehicle's dash display after the ride was completed. The power consumption calculated in the analysis does not include the regeneration adjustment. Power calculated from the data set and regeneration info from the dash were used to approximate per trip regeneration. *All metrics calculated in this analysis use actual power consumption and per trip actual power consumption approximations.*

The actual power consumed in 20.4 miles was 6.375kWh. Using a national average of 26 miles per gallon, 0.785 gallons would be consumed over 20.4 miles. The cost of 6.375kWh of battery charge is 71% less than the cost to pump 0.785 gallons of gas. *At 26 miles per gallon, every $100 spent on gas is about $30 bucks for EV charging.*

The ride share data contains information from 3 separate trips. Trips 1 and 3 were both over 9 miles. They also include data collected while traveling on the highway. Data collected from trip 2 shows city street stop and go traffic.

Comparing data collected from all 3 trips indicates an increase in energy usage at higher velocities. The data also indicates that higher accelerations correlate to higher energy usage. This makes sense, doing more requires more energy.

Figures 2.5 and 2.6 imply that energy trends upward as velocity and acceleration increase. However, observing Figure 3.3 reveals that trip 3 had the greatest average velocity yet, it was the most energy efficient per mile. Trip 3 also had the lowest acceleration rate. This can be recognized in Figure 2.1 where velocity is plotted for all three trips. Trip three has far less stops (places where the graph drops to 0). The efficiency of trip 3 is related the low average acceleration. Observing the constant acceleration bar in the 60MPH+ category of Figure 2.5, the bar is noticeably shorter than higher accelerations in lower velocity ranges. *This means less energy can be used by traveling at a more constant rate, regardless of the vehicles speed*. A deeper analysis of energy efficiency in relation to heavy vs light acceleration at different velocities could provide more useful insights. Nevertheless, such analysis wouldn't be provided here, for free.

Here is a quick reference on the increasing power consumption with speed phenomenon. According to TomTom article, Greener driving, fuller pockets, "driving at higher speeds increases aerodynamic drag and increases fuel consumption" (*How the Way You Drive Can Make Your Car More Efficient | TomTom Newsroom*, 2024).

Battery VS Gas Power

When considering options for transportation, re-occurring costs are a high priority. After insurance and car note payments, fuel is the next most costly obligation.

Fuel is the energy source for standard internal combustion engines. Batteries are the energy source for electrically powered vehicles. An energy source efficiency comparison is provided here.

Calculation Metrics

- *Raw Data*:
  - Speed and energy data collected from an all-electric Chevy Equinox EV
  - Data collection Duration: 60min (From Analysis)
  - Distance Traveled: 20.4mi (From Dash Display)
  - kWh used: 6.375kWh (From Dash Display)
- Collected Metrics:
  - Average cost of electricity (Louisiana): ------------ $12\ \frac{cents}{kWh}$
  - Average Price of Gas (USA): ------------------------- $\$3.30\ per\ Gallon$
  - New Vehicle average MPG (2022): ------------------$26MPG$
    - *Sources*
      - (*Electricity Rates by State (February 2020) | ChooseEnergy.com®*, 2020)
      - (*In 2024, U.S. Retail Gasoline Prices Averaged about 20 Cents Less than in 2023 - U.S. Energy Information Administration (EIA)*, 2024)
      - (*FOTW# 1177, March 15, 2021: Preliminary Data Show Average Fuel Economy of New Light-Duty Vehicles Reached a Record High of 25.7 MPG in 2020*, 2021)

Figure 1: Energy Source Cost Efficiency (Battery VS Gasoline consumption)

Figure 1.0 - Battery vs Gas Power consumption		
#	**Battery**	**Gas**
1	**[kWh] consumed - 20.4mi**	**[GAL] consumed - 20.4mi**
2	6.38	0.78
3	**Cost - 20.4mi Trip**	**Cost - 20.4mi Trip**
4	$0.77	$2.59
5	**Average Cost Per Mile**	**Average Cost Per Mile**
6	$0.04	$0.13
7	**85[kWh] battery ~ 272 [miles] COST TO CHARGE**	**10.5-[GAL] Tank ~ 272 [miles] COST TO FILL**
8	$10.20	$34.65
9	**Percent Savings**	
10	71%	

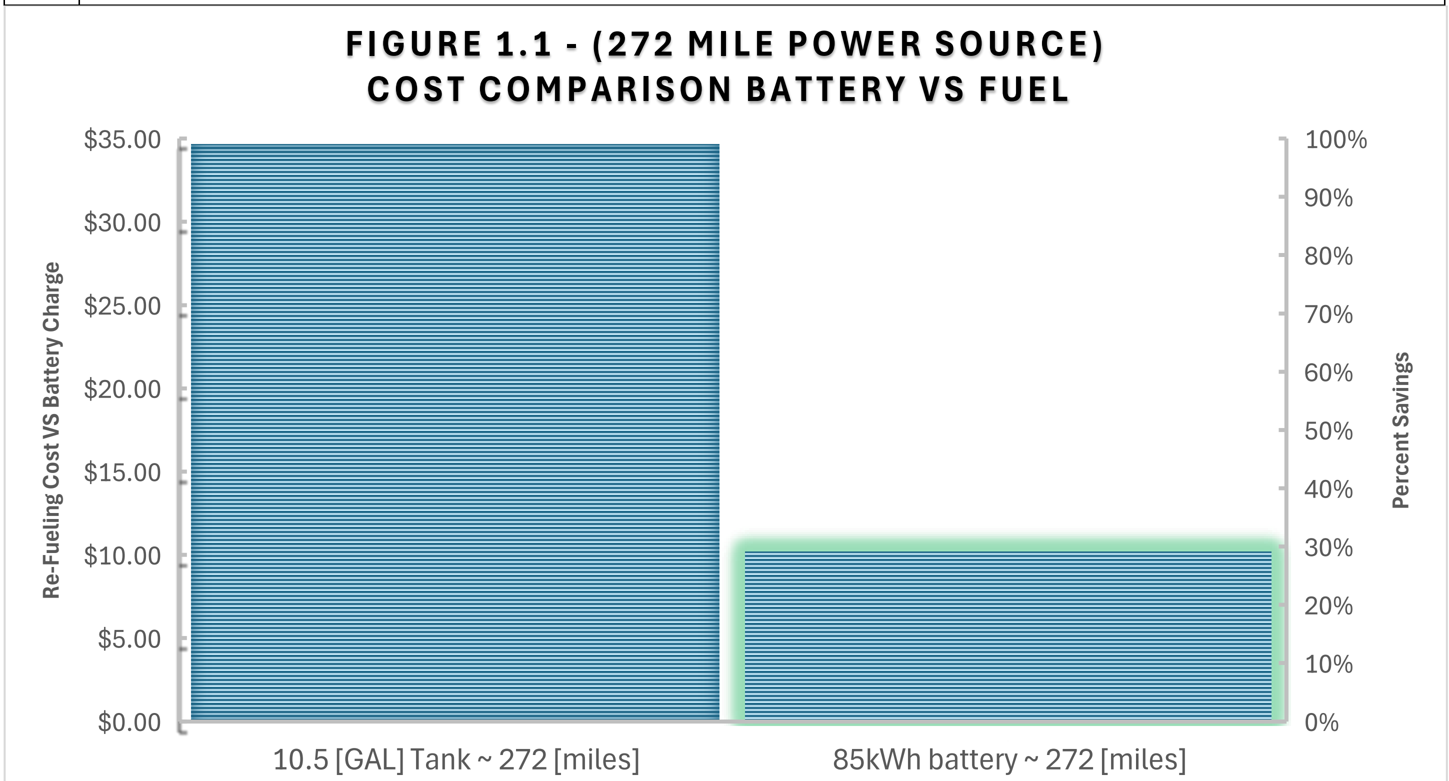


Figure1.1 - References Row 7 & 8 from Figure 1. Figure indicates that it costs gasoline vehicles 71% more to travel the same distance as an E

Ride Share Data over 60.56 minutes & 20.4 miles

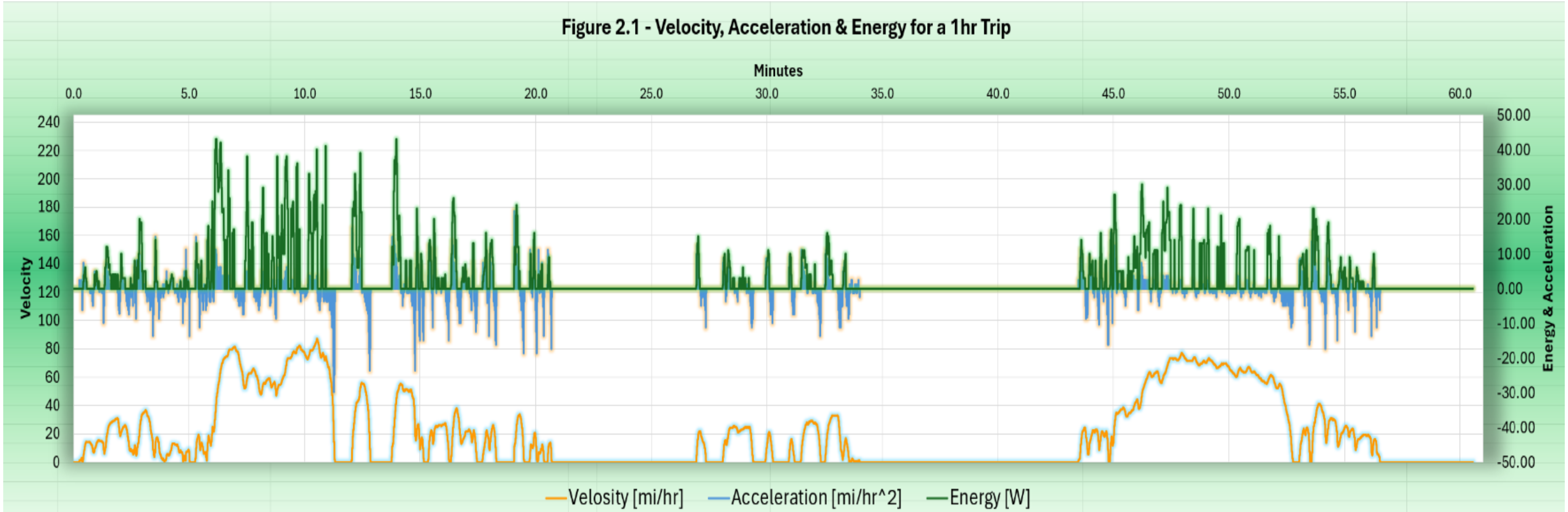
Figure 2 - Complete Data Set Analysis

#	Data Collected	From Dash
1	Distance Traveled [miles]	Distance Traveled [miles]
2	20.21	20.40
3	Average Energy Drain [kW]	Regeneration Miles
4	0.01	7.80
5	Total Power used [kWh]	Actual Total Power used [kWh]
6	10.36	6.38
7	Percent of Battery Used	Percent of Battery Used
8	12.19%	7.50%
9	Time energy is consumed [min]	Trip Cost 6.375 [kwH]
10	13.37	$0.77
	mi/kWh	mi/kWh
11	1.95	3.20
12	Approx [kWh] Regenerated	
13	3.99	
14	Approx Regen [mi/kWh]	
15	1.95	
16	Percent Regenerated [mi/kWh]	
17	0.38	
18	Cost to Fully Charge Completely Drained 85kWh Battery	
19	$10.20	
20	Average Velocity [mi/hr.]	
21	27.21	
22	Average Acceleration [mi/hr^2]	
23	3.99	
24	Average Power Consumption [Wh]	
25	1.89	

Important implications

- kW regenerated is not included in the data collected.
  - Regeneration and Actual Total Power Used are obtained from the vehicle's dashboard.
  - Subsequent calculations in this analysis use Actual Total Power obtained from the vehicle's dashboard. (6.38kWh)
  - Percent Regenerated is calculated using the Total Power from the data collection and Actual Total Power.
    - Considering the small dataset, the value likely contains some error. It is used to approximate regeneration for each trip later in this analysis.
- Average Energy Drain calculation only includes times when energy is actively being consumed.
- Average Velocity and Power Consumption include times when the vehicle is idle during each trip but not idle times between trips.
- Average Acceleration does not include times when vehicle is idle, at a constant speed, or decelerating.

Figure 2.1 illustrates Velocity, Acceleration, and Energy data from three rideshare trips



- Trips 1 & 3 include a highway slide where velocity approaches 80MPH.
- Trip 2 illustrates city street stop and go traffic.
- The adjacent pie graph shows the remaining battery life after completing all 3 trips.

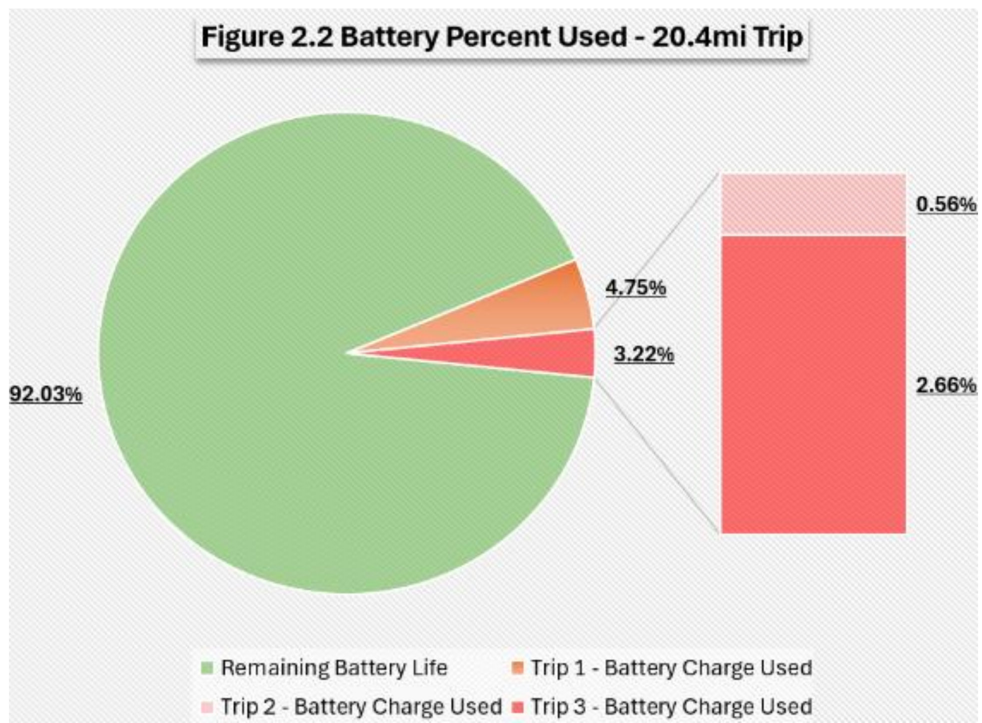


Figure 2.3 illustrates Average Velocity, Acceleration, and Energy data from three rideshare trips

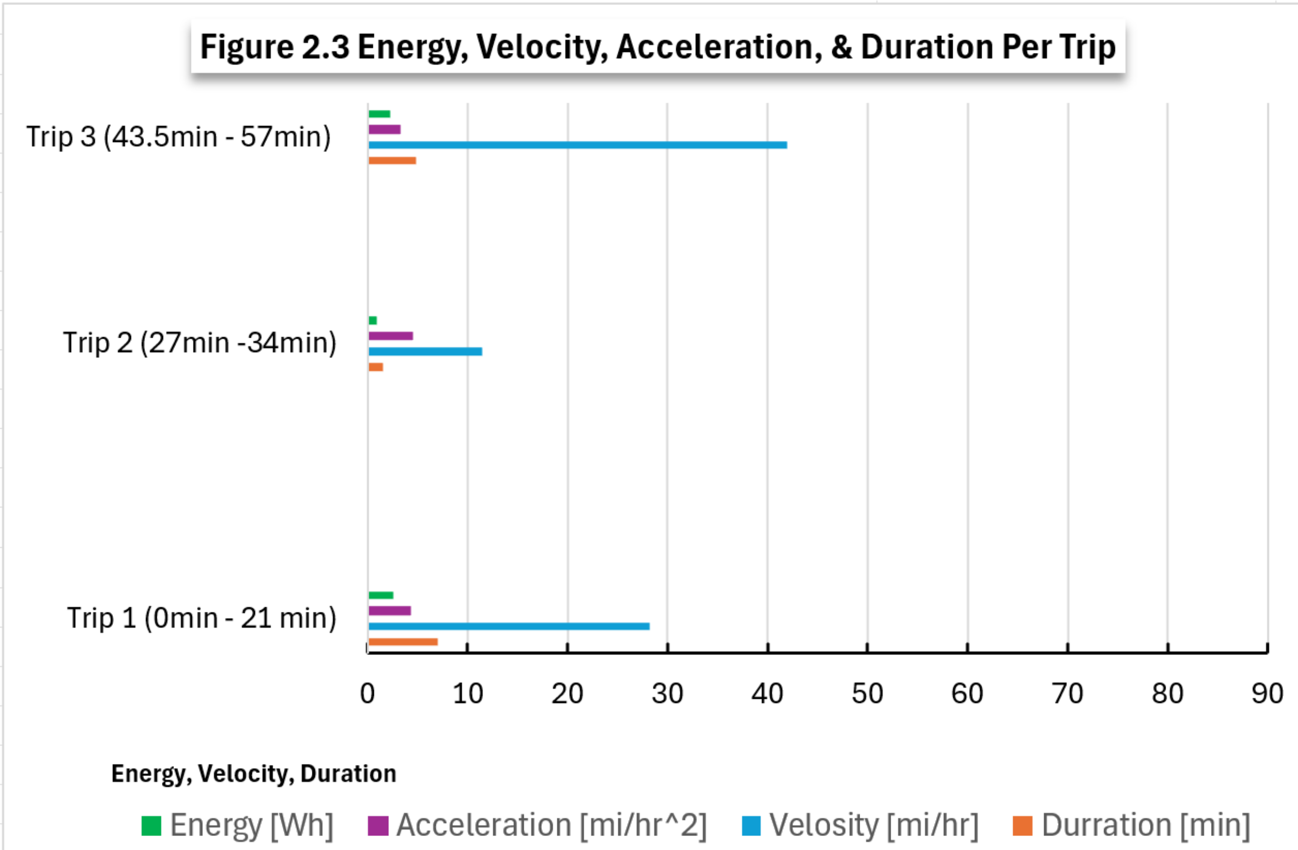


Figure 2.3 – The trips with larger average velocities use more energy.

Figure 2.4 takes a deeper look at velocity's effect on energy consumption.
Figure 2.4.1 shows the relation between acceleration and energy consumption.

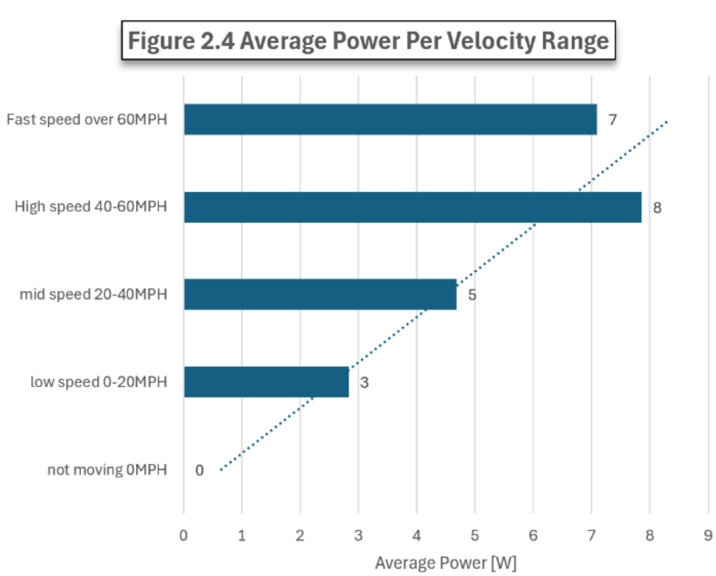


Figure 2.4 – At faster speeds, the electric vehicle uses more energy.

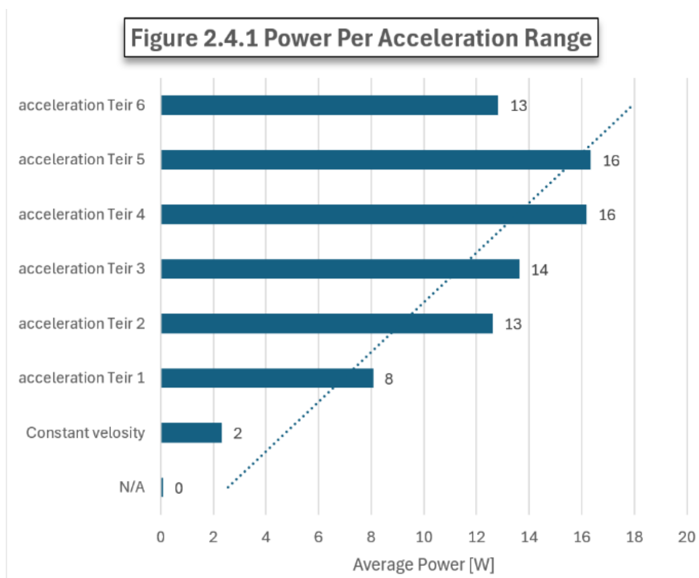


Figure 2.4.1 – Faster acceleration uses more energy.

Figure 2.5 Displays the acceleration tiers' average powers over different velocity ranges. In other words, for each velocity range, accelerations that occur are grouped into tiers. Each bar on the bar graph is the average power corresponding to the tiers' acceleration values that occur within one of the velocity ranges.

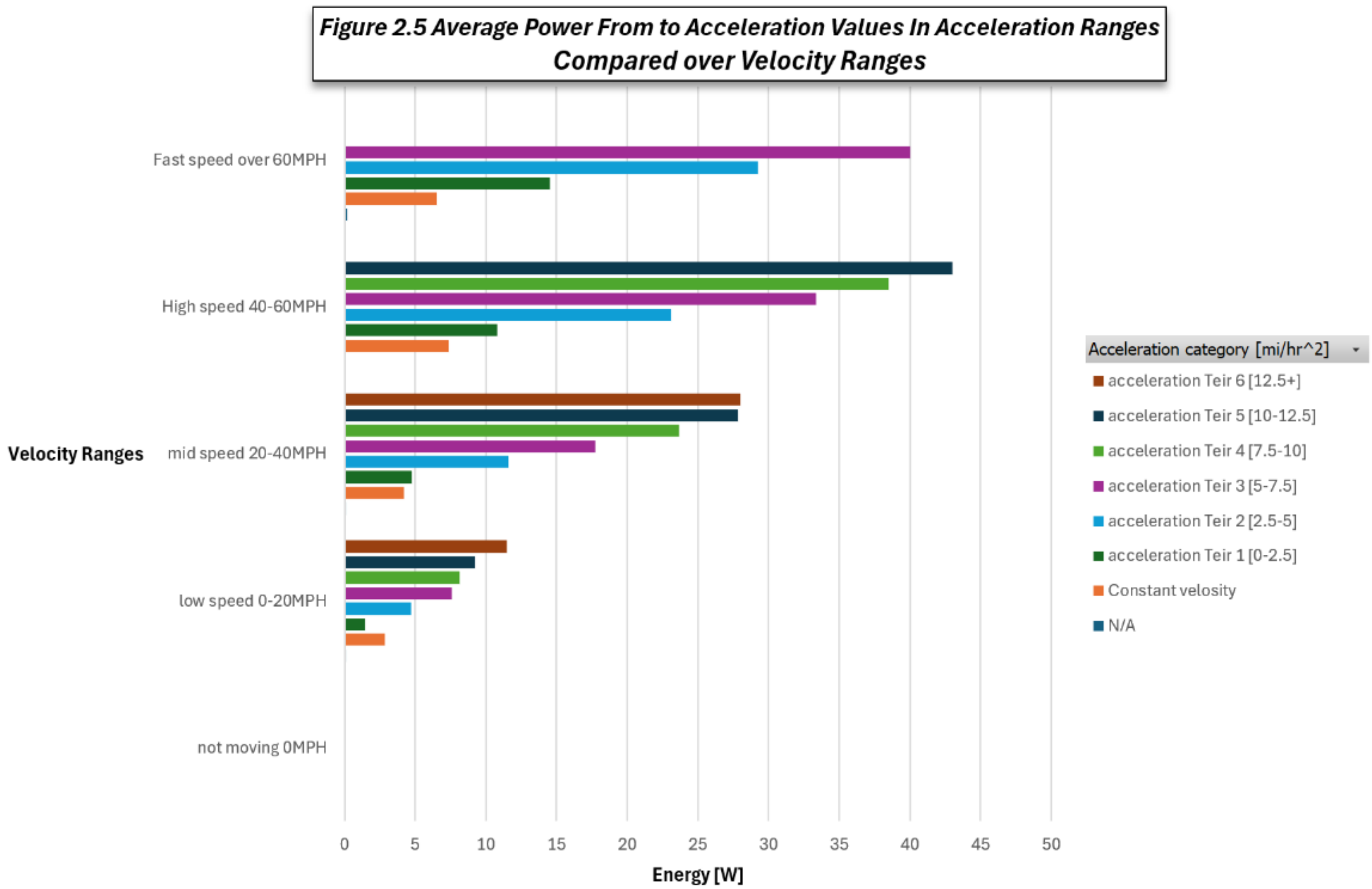


Figure 2.5 – Equal acceleration rates will consume more power when the vehicle speed is increased.

Figure 2.5 – No tier 6 accelerations occur in the 40-60 mile per hour range.

Figure 2.5 – For velocities Over 60 miles per hour, no tier 5 or tier 6 velocities occur.

Figure 2.5 – Indicates the vehicle rarely accelerates at high rates at high speeds. The reduced power production for velocities over 60 miles per hour in figures 2.4 and 2.4.1 are related to this circumstance**.**

Figure 2.5 1 – Traveling at slower speeds and accelerating less will reduce power consumption, however, it will take longer to reach the destination.

Figure 2.6 is another visualization showing the combined effect of velocity and acceleration on power output. Each line is a velocity range plotted by the average power at different accelerations.

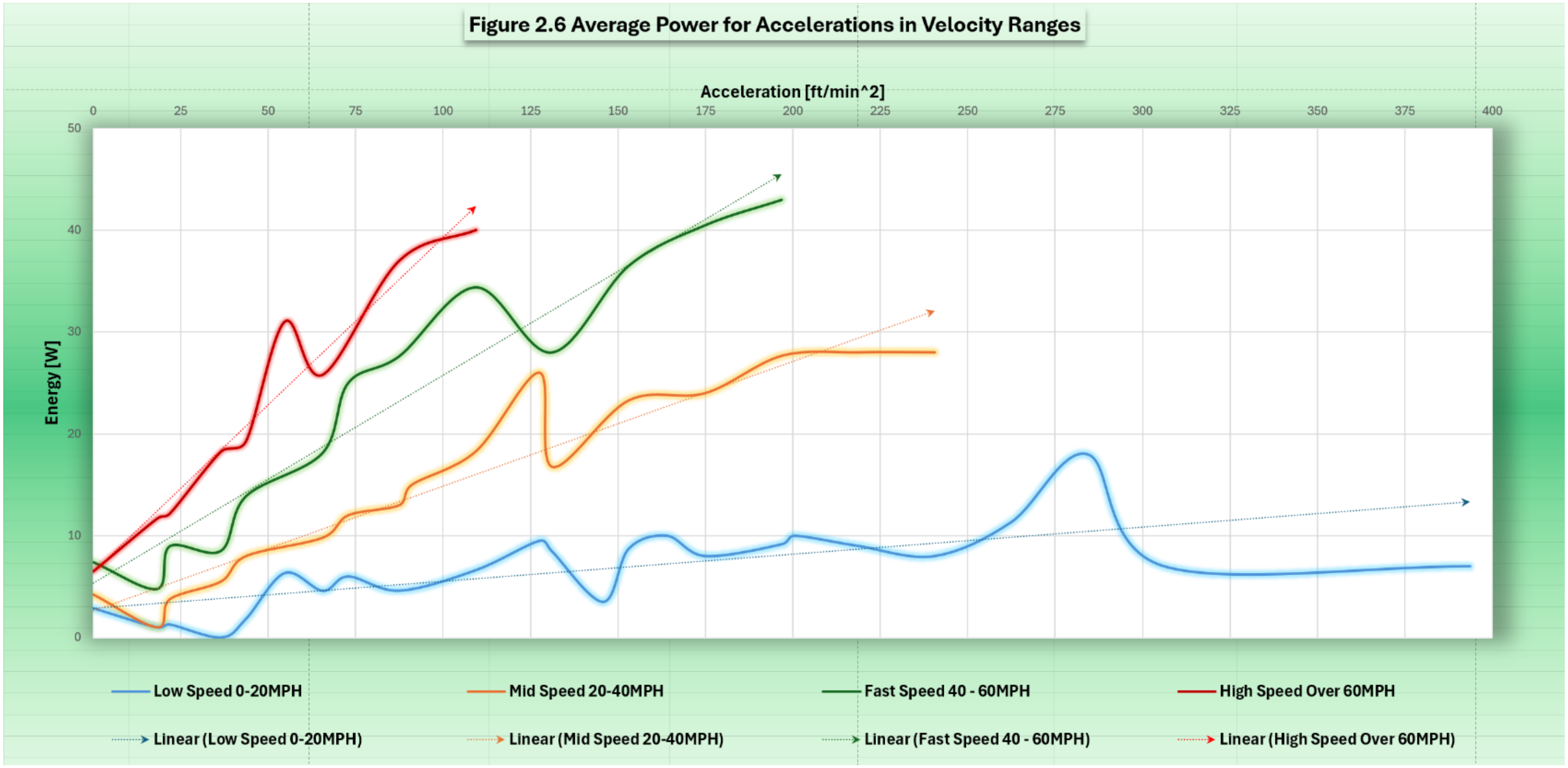


Figure 2.6 – Trend lines show increased power consumption as velocity and acceleration increase.

Figure 2.6 – Higher velocity ranges have smaller max acceleration rates.

Isolated trip Data – Trip 1, Trip 2, Trip 3

Figure 3 – Isolated Trip Data: Trip 1, Trip 2, Trip 3

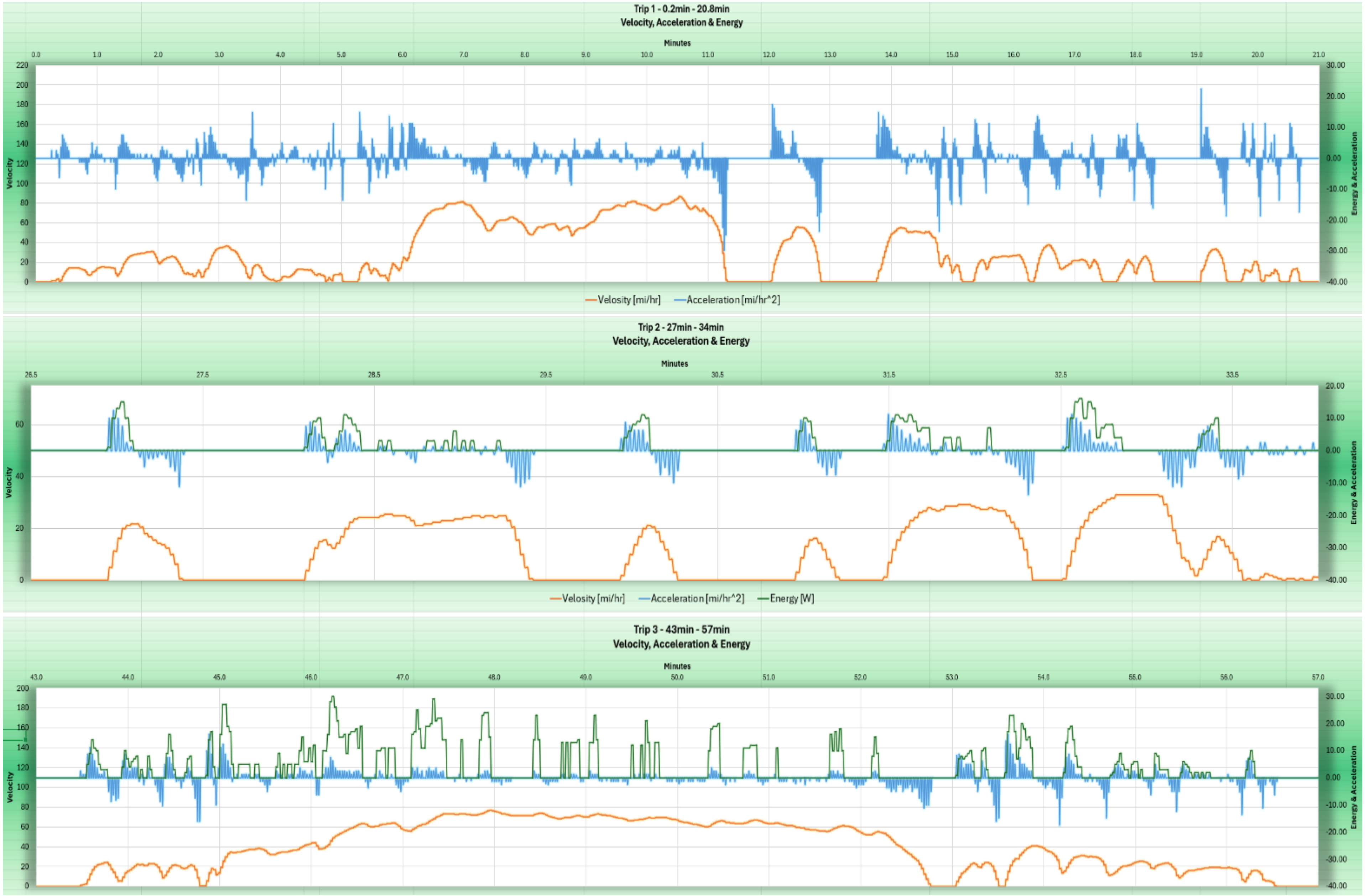


Figure 3.1- Trip 1 Analysis

Trip 1 (0min - 21 min)	
Without Regen	With Regen
mi/kWh	mi/kWh
1.57	1.95
Distance Traveled [miles]	Regenerated [kWh] (Using Approximate % Regenerated)
9.69	2.14
Average Energy Drain [kW]	Average Energy Drain [kW]
0.013	N/A
Total Power used [kWh]	Approx. Power used [kWH]
6.18	4.04
% Battery Charge Used	Approx. Battery Charge Used
7.27%	4.75%
Cost to Replace Total Power used	Cost to Replace Approx. Power Loss
$0.74	$0.48
Trip 2 (0min - 21 min)	
Energy Consumption Duration [min] Trip 1	
6.97	
Average Velocity [mi/hr.]	
28.23	
Average Acceleration [mi/hr^2]	
4.236	
Average power consumption [Wh]	
2.547	

Figure 3.1 – kWh regenerated were approximated at 38% of the trip's total recorded kWh usage. [-10%]

Figure 3.1 – Average velocity and power consumption include times when vehicle is idle.

Figure 3.1 – Average Acceleration does not include times when vehicle is idle, at a constant speed, or deaccelerating.

Figure 3.1 – Comparing all three trips, trip 1 uses the most power. Although Trip 1 and Trip 3 were similar distances, Trip 1 consumes 44% more power than trip 3.

Figure 3.2 - Trip 2 Analysis

Trip 2 (27min -34min)	
Without Regen	**With Regen**
mi/kWh	**mi/kWh**
1.86	1.95
Distance Traveled [miles]	**Regenerated [kWh] (Ussing Approximate % Regenerated)**
1.36	0.25
Average Energy Drain [kW]	**Average Energy Drain [kW]**
0.0070	N/A
Total Power used [kWh]	**Approx. Power used [kWH]**
0.73	0.48
% Battery Charge Used	**Approx. Battery Charge Used**
0.86%	0.56%
Cost to Replace Total Power used	**Cost to Replace Approx. Power Loss**
$0.09	$0.06

Trip 2 (27min -34min)
Energy Consumption Duration [min] Trip 2
1.57
Average Velocity [mi/hr.]
11.4
Average Acceleration [mi/hr^2]
4.451
Average power consumption [Wh]
0.871

Figure 3.2 – kWh regenerated were approximated at 38% of the trip's total recorded kWh usage [-10%]

Figure 3.2 – Average velocity and power consumption include times when vehicle is idle.

Figure 3.2 – Average Acceleration does not include times when vehicle is idle, at a constant speed or deaccelerating.

Figure 3.2 – Comparing all three trips, Trip 2 uses the least amount of power.

Figure 3.2 – Short trip duration with a low average velocity.

Figure 3.2 – Trip 2 had the greatest per trip average acceleration.

Figure 3.3 - Trip 3 Analysis

Trip 3 (43.5min - 57min)	
Without Regen	**With Regen**
mi/kWh	**mi/kWh**
2.65	1.95
Distance Traveled [miles]	**Regenerated [kWh] (Using Approximate % Regenerated)**
9.16	1.20
Average Energy Drain [kW]	**Average Energy Drain [kW]**
0.011	N/A
Total Power used [kWh]	**Approx. Power used [kWH]**
3.46	2.26
% Battery Charge Used	**Approx. Battery Charge Used**
4.07%	2.66%
Cost to Replace Total Power used	**Cost to Replace Approx. Power Loss**
$0.42	$0.27

Trip 3 (43.5min - 57min)
Energy Consumption Duration [min] Trip 3
4.83
Average Velocity [mi/hr.]
41.963
Average Acceleration [mi/hr^2]
3.277
Average power consumption [Wh]
2.245

Figure 3.3 – kWh regenerated were approximated at 38% of the trip's total recorded kWh usage. [-10%]

Figure 3.3 – Average velocity and power consumption include times when vehicle is idle.

Figure 3.3 – Average Acceleration does not include times when vehicle is idle, at a constant speed or deaccelerating

Figure 3.3 – Trip 3 was the most efficient ride. When comparing it to other trips, less kWh were used per mile.

Figure 3.3 – Trip 3 also had the lowest average acceleration rate. Low acceleration is a key factor contributing to this trip's superior efficiency.

Figure 3.3 – Although Trip 1 and Trip 3 were similar distances, Trip 1 consumes 44% more power than trip 3.

Figure 3.4 - Trip 1: Shows an acceleration from 0MPH to 40MPH. Graph represents a 45 second interval.

<u>Figure 3.4 - **Trip 1** - 45[s] interval</u>

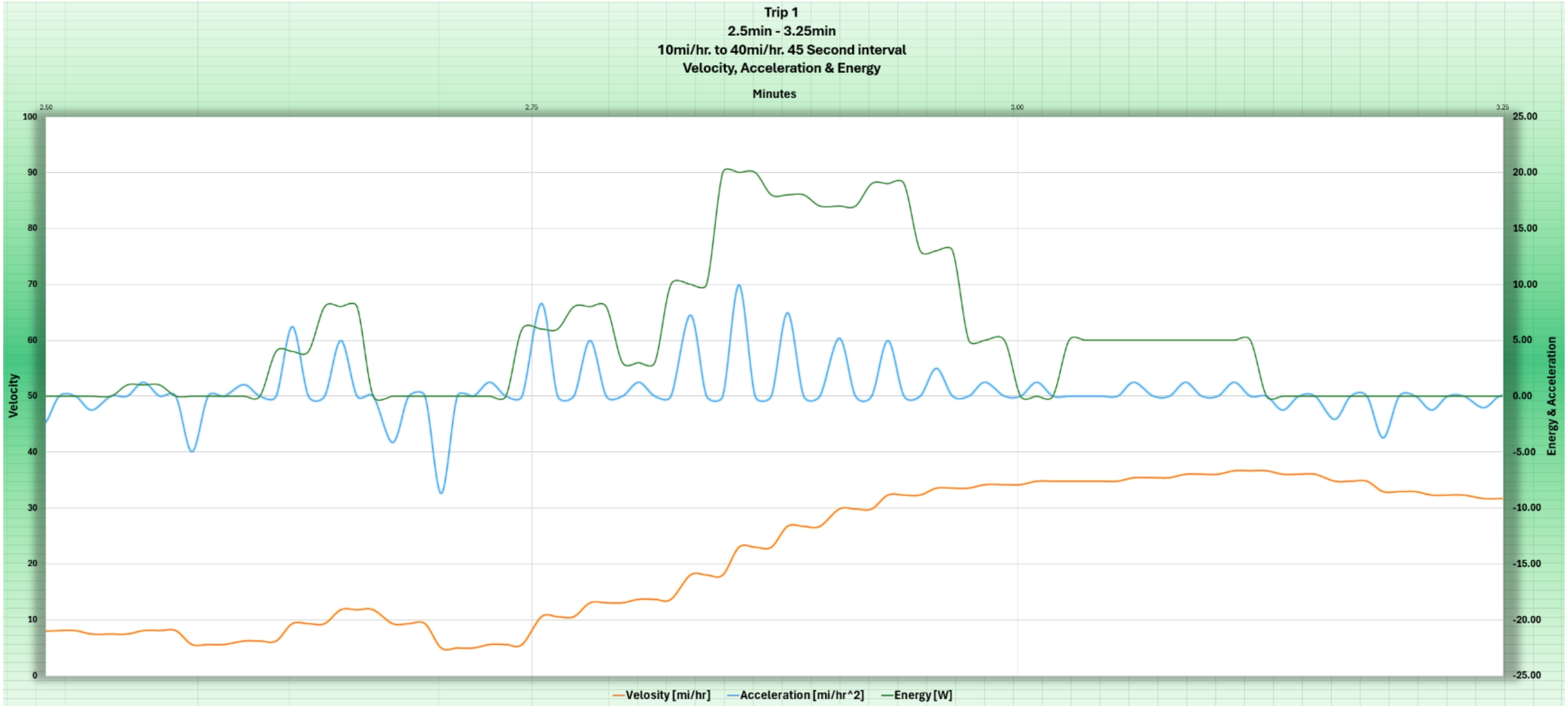


Figure 3.5 – Trip 1: Shows an acceleration from 0MPH to 80MPH. Graph represents a 1min 30 second interval.

<u>Figure 3.5 - **Trip 1** - 1[min] 30[s] interval</u>

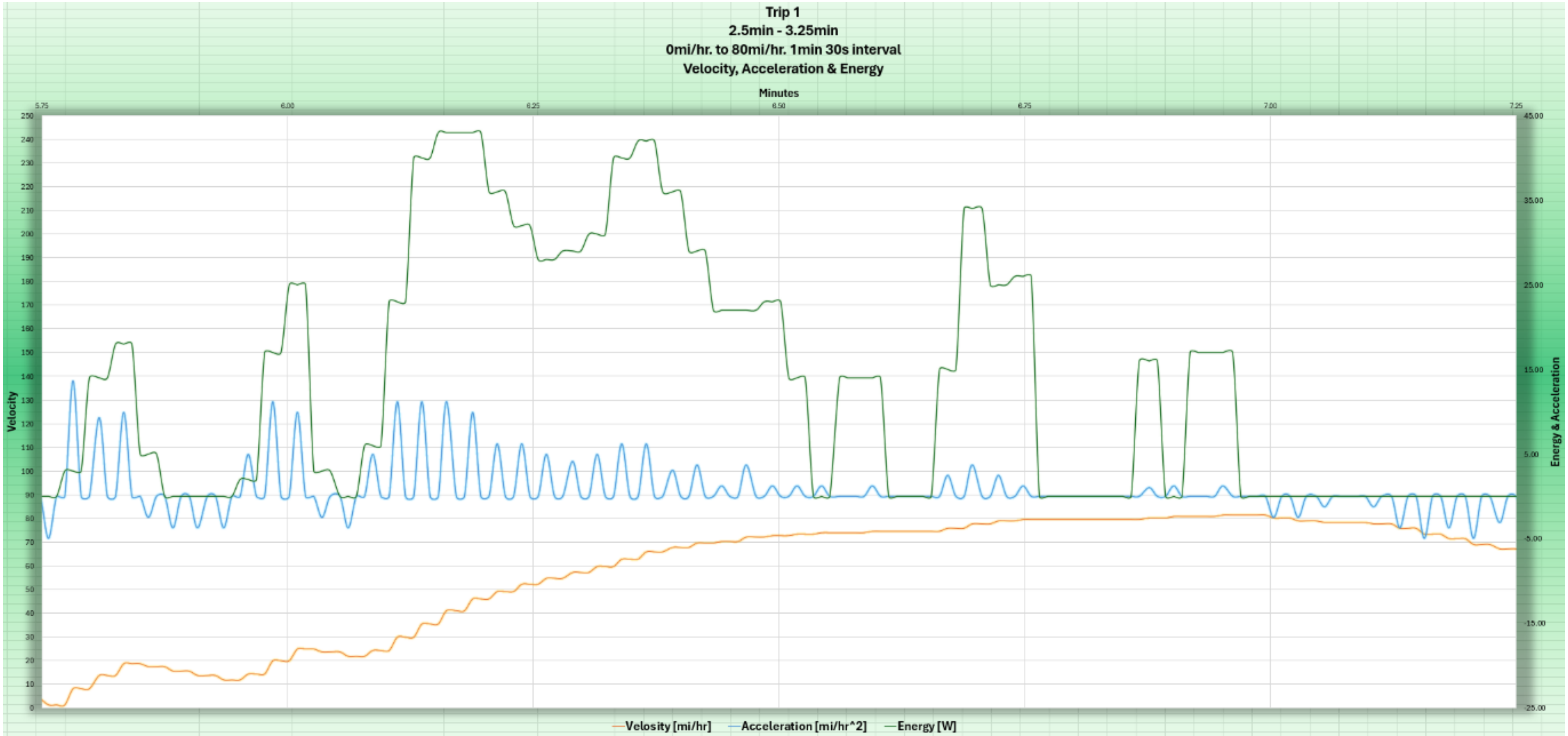
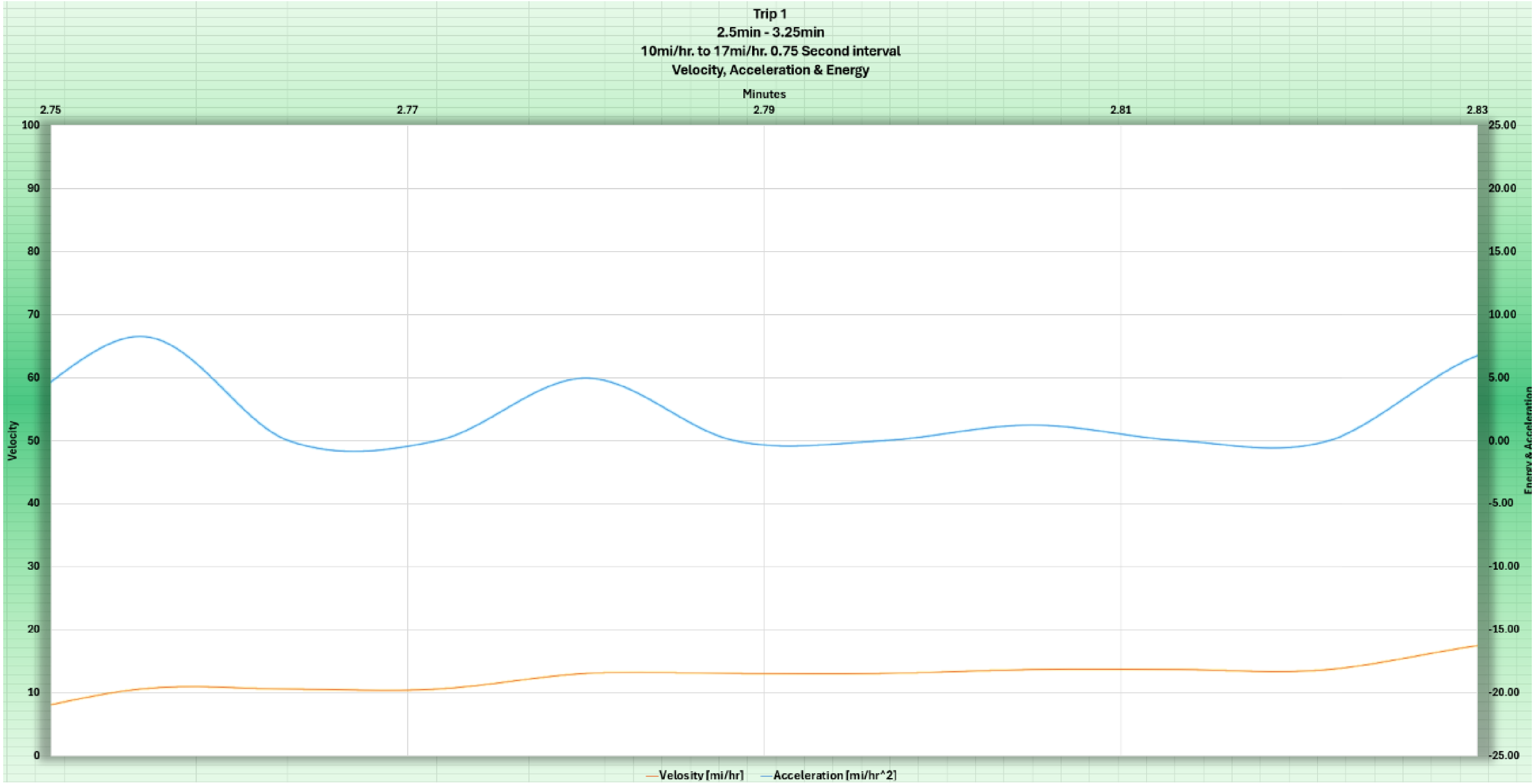


Figure 3.6 – Trip 1: Shows an acceleration from 10MPH to 17MPH. Graph represents a 0.75 second interval.

Figure 3.6 - **Trip 1** - 0.75[s] interval



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