



GOAL

Battle Motors' objective was to acquire real-time data regarding route information and vehicle performance under demanding conditions.

SUMMARY

The organization leveraged the capabilities of the Battle Motor's proprietary RevolutionOS™ (RevOS) platform data from the routes ran in Tampa, Florida on September 18, and September 20, 2023, with a temperature range between 75 – 96 degrees Fahrenheit.

APPLICATION

Residential Refuse

OVERVIEW

FCC Environmental Services and Battle Motors conducted a rigorous operational test of the Battle Motors Battery Electric Vehicle (BEV) LNT Curbtender RL equipped with a 240kWh battery pack. This assessment took place within both the urban and rural areas of Hillsborough County, subjecting the vehicle to the demands of a typical workday.

Throughout an 8-hour day, during which temperatures reached a maximum of 96 degrees Fahrenheit, the Battle Motors BEV conducted residential refuse pickups and navigated the narrow streets and alleys in Hillsborough County with notable agility. The ability to remotely monitor the truck's performance in real-time proved to be significant during the testing phase, as it provided kWh usage data.

RevOS captured key performance metrics of the vehicle, including comprehensive route data. This robust data collection and analysis process formed the foundation for the evaluation of Battle Motors BEV's performance within the urban and rural environments of Hillsborough County.

MATERIALS

BEV (Battery Electric Vehicle) LNT (Low Narrow Tilt) - Curbtender 11CY QuantumMD Rear Loader – Weight (empty) is 25,980 lbs.

TRUCK DATA AT HIGH LEVEL

The information provided pertains to data collected from a single truck over one day. It is important to clarify that these data collections did not occur on consecutive days.

Farthest Distance Traveled in One Day	90.2 Miles
Highest Speed	70 MPH
Maximum Battery Required Recommendation	240 kWh
Type of pick up - Residential or Commercial	Residential
Cans / Stops	600*

**An estimate of cans collected on the longest day.*

DATA REVIEW

The data presented was gathered during a single-day route. Throughout an 8-hour workday, the truck covered 90.2 miles, encompassing back-road and freeway driving. Notably, the lowest point the "EV (Electric Vehicle) state of charge" (battery percentage) reached was 37%. Chart 1 (below) provides a top-level overview of select data obtained through RevOS installed in the truck, which combines data from the truck's CAN system, chassis, body, and GPS.

A selection of routes was examined and collected by the FCC truck during the data harvesting process. Subsequently, Battle Motors processed the data acquired from the REVOS system and transferred it into the Battle Motors electric reporting tools.

This data includes:

- Location
- Latitude
- Longitude
- Altitude
- Speed
- Bearing
- Route Driven
- Total Vehicle Distance

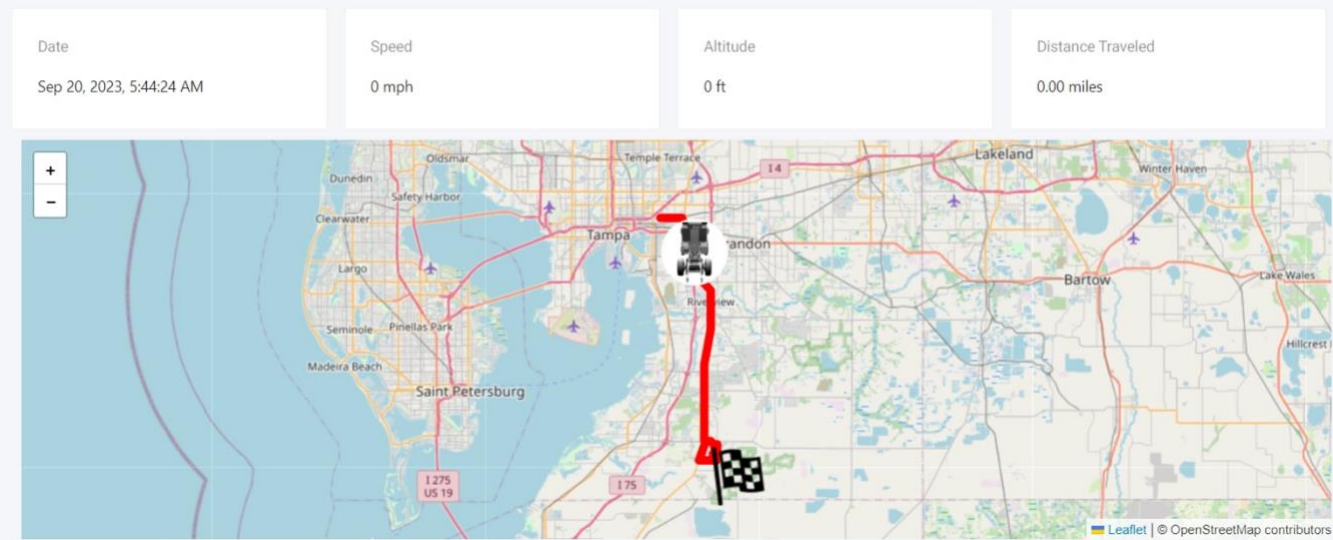
SUMMARY OF DATA COLLECTED

Below is a sample data collection of location, time, current speed, altitude, and distance traveled in a trip (first half of the trip made on Sept. 18).

Start	End	Duration	Status	Distance Traveled	Average Speed	Max Speed	Start SOC	End SOC
Sep 20, 2023, 5:44:24 AM	Sep 20, 2023, 10:36:08 AM	4 hrs, 51 mins, 44 secs	Completed	45.14 miles	9 mph	70 mph	100%	66%

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[Route Map](#) [Trip Statistics](#) [GPS Speed Graph](#)



BEV EFFICIENCY REVIEW

During the 90.2-mile, 8-hour run, the truck achieved an average of 1.12 kWh per mile, demonstrating strong electric performance for demanding routes. The driver extended the route another 150 cans because he had 75% battery life left at the last can. He was also able to maneuver narrow streets much more efficiently by performing U-turns, which he otherwise could not perform in an ICE refuse truck.

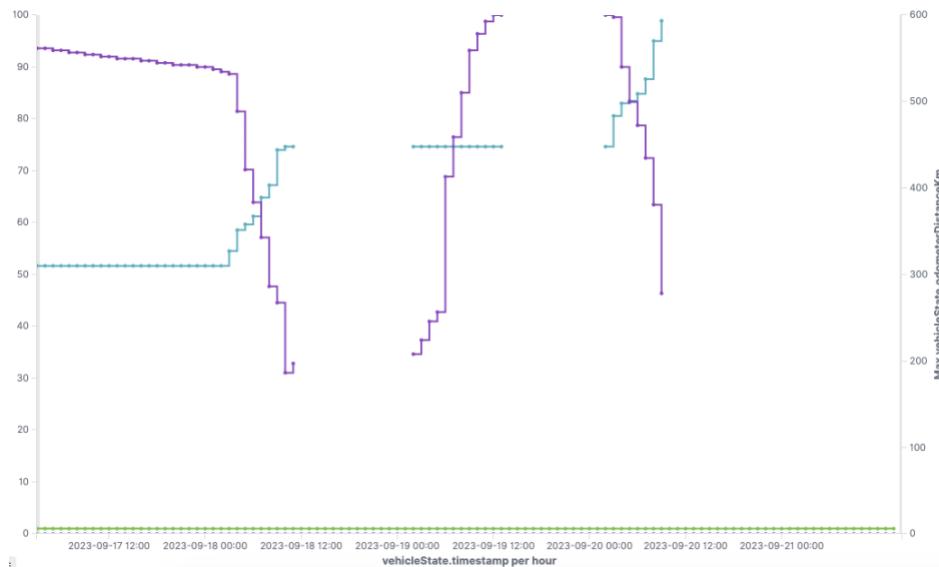
In summary, this demonstrates that a Zero Emissions Vehicle (ZEV) can successfully complete extended routes, all while operating at a significantly lower decibel level compared to its ICE counterpart.

DUMP SCALES (12 HOURS)

Total full	31,630 lbs.
Total empty (after dump)	26,130 lbs.
Payload	5,500 lbs.

EV STATE OF CHARGE (SOC) OVER TIME

September 18 - September 20, 2023



BATTERY RECOMMENDATION

Battle Motors offers two primary battery usage configurations for its trucks, catering to a broad range of usage scenarios in the market. These configuration choices were developed in response to the increasing market demand for greater diversity in usage. Currently, the following pack configurations are available in 240 kWh and 400 kWh.

Truck	kWh*
FCC Truck 1	240

CONCLUSION

As demonstrated in the chart above, the battery system in the vehicle had not yet completed State of Charge (SOC) reconfiguration, which explains the starting charge of 89% and faster discharge rate. SOC reconfiguration is needed on newly assembled electric vehicles so that the Battery Management System (BMS) may learn the bounds of operation for the system. Searching for a charger added another 22 miles to the route and only resulted in a 2% additional charge. This was because the public charger used was a 6.7kWh charger plugged in for a 45-minute lunch period. With a full state of charge and without having to search for a public charger, it is assumed that the driver could easily complete the full route in a day while maintaining a legal payload of up to 5 tons.

The driver noted that the truck was vastly more maneuverable than its ICE counterparts, as well as much smoother to operate. He described the LNT BEV as feeling more like a car than a heavy-duty truck. An analysis of the route data revealed that the 240-kWh capacity truck efficiently performed a modified route, meeting customer expectations for FCC in Hillsborough County. As the truck continues its tenure with FCC, further insights and advancements will elevate the potential of continued innovative solutions.

BATTERY SPECIFICATIONS

Battery Cell Chemistry	LFP
Operational Temperature Range	-35°C - 60°C
Rated Energy	240kWh
Maximum Continuous Charge Current	346A
Maximum Continuous Charge Power	240kW
Peak Charge Power	480kW
Maximum Continuous Discharge Power	240kW
Peak Discharge Power	556kW
Thermal Management	Cooling: Liquid Cooling Heating: Heating film
Operational Voltage Range	540V - 750V

POWERTRAIN SPECIFICATIONS

Drive Motor	BorgWarner Cascadia Motion HVH410-150
Drive Inverter	BorgWarner Cascadia Motion PM250
Peak Torque	2050Nm
Peak Power	300kW
Maximum Motor Speed	6,000RPM
Transmission	Direct Drive
Cooling Medium	Dexron VI
Motor Assembly Mass (Motor Only)	140kg
Maximum Efficiency	95%