Zero Emission Truck and Pilot Commercial Deployment Project

The Green On-Road Linen Delivery Project Final Report

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California Climate Investments
Cap and Trade Dollars at Work

CALSTART

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AmeriPride

Motiv
it's inEVitable

Preface

In 2007, the *California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007* (AB 118, Statutes of 2007, Chapter 750) was signed into law. AB 118 created the Air Quality Improvement Plan (AQIP), a voluntary incentive program administered by the California Air Resources Board (CARB), to fund clean vehicle and equipment projects, air quality research and workforce training. As required in Health and Safety Code (HSC) Section 44274(a), the Board adopted regulatory guidelines in 2009 for AQIP. The Guidelines for the AB 118 Air Quality Improvement Program (Guidelines)[1] define the overall administrative requirements and policies and procedures for program implementation based on the framework established in statute. Central to the Guidelines is the requirement for a Board-approved annual funding plan developed with public input. The funding plan is each year's blueprint for expending AQIP funds appropriated to CARB in the annual State Budget. The funding plan focuses AQIP on supporting development and deployment of the advanced technologies needed to meet California's longer-term, post-2020 air quality goals.

In 2012, the Legislature passed and Governor Brown signed into law three bills –AB 1532 (Pérez, Chapter 807), SB 535 (De León, Chapter 830), and SB 1018 (Budget and Fiscal Review Committee, Chapter 39) that established Green Gas Reduction Fund (GGRF) to receive Cap-and-Trade auction proceeds and to provide the framework for how the auction proceeds will be administered in furtherance of the purposes of AB 32, including supporting long-term, transformative efforts to improve public health and develop a clean energy economy. The suite of implementing legislation offers strong direction for investing a portion of the auction proceeds to benefit disadvantaged communities, including specific allocation requirements in SB 535.

In 2014, the Legislature appropriated $200 million dollars in GGRF monies to establish a Low Carbon Transportation GGRF program that CARB is implementing in coordination with the AQIP AB 118 programs. In May of 2016, Governor Brown's proposed budget included $500 million dollars in GGRF monies toward the Low Carbon Transportation program. Projects funded by the Low Carbon Transportation GGRF program must reduce GHG emissions and further the purposes of AB 32, with a strong emphasis on benefiting disadvantaged communities.

In order to identify the priority investments that facilitate GHG emission reductions, the Legislature directed the development of the Cap-and-Trade Auction Proceeds Investment Plan.[2] The Fiscal Year 2016-2017 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program (FY 2016-17 Funding Plan), which was released in May 2016, calls for projects that accelerate the development and deployment of advanced mobile source technologies and very low carbon fuels to help achieve the State's near-term and longer-term GHG emission reduction goals. In addition, the FY 2016-17 Funding Plan directs a minimum 50 percent of funding from GGRF to be allocated toward projects that benefit disadvantaged communities and a minimum of 10 percent to be invested directly in disadvantaged communities. The FY 2016-2017 Funding Plan is designed to build upon previous funding cycles. Due to a decrease in the appropriated funds from $350 million to $95 million for Low Carbon Transportation investments, CARB implemented a scaled back version of its FY

[1] The Guidelines for the AB 118 Air Quality Improvement Program are found in Title 13, California Code of Regulations, Chapter 8.2.

[2] The Cap-and-Trade Auction Proceeds Investment Plan is available at http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/investmentplan.htm.

2015-16 Funding Plan. Therefore, many projects that were approved by CARB Governing Board could not be implemented. The FY 2016-17 Funding Plan prioritized these projects. Included in this prioritization is the Zero-Emission Truck and Bus Pilot Commercial Deployment Projects.

CARB solicited projects for the Zero-Emission Truck and Bus Pilot Commercial Deployment Projects October 1, 2015 as approved by the Board through the FY 2014-2015 and FY 2015-2016 Funding Plans for AQIP and Low Carbon Transportation GGRF Investments.[3,4] In approving the FY 2015-16 Funding Plan in June 2015, the Board approved staff's recommendation to combine zero-emission truck and bus pilot project allocations from the two fiscal years' Funding Plans into one solicitation. The solicitation captured the types of technologies and pilot projects eligible for funding under both funding plans. The solicitation also stipulated that projects not funded with FY 2015-16 funds may be considered for additional funds appropriated before June 30, 2016 at CARB's sole discretion.

Executive Summary

The Green On-Road Linen Delivery Project was a collaborative effort between AmeriPride Linen Delivery Services (later acquired by Aramark), the San Joaquin Valley Air Pollution Control District, Motiv Power Systems (Motiv), and CALSTART to deploy twenty-one (21) zero emission Class 6 battery electric (BEV) walk-in vans along with supporting infrastructure at four locations in the San Joaquin Valley to provide linen delivery services. The commercial pilot project involved AmeriPride locations in Stockton, Merced, Fresno and Bakersfield; all within disadvantaged communities in those cities. The vehicle powertrains were built by Motiv with the body work completed by Utilimaster with funding from a $7,125,515.00 grant from the California Climate Investments initiative through CARB. Additional cash match was provided by AmeriPride Linen services. The project was administered by the grantee, the San Joaquin Valley Air Pollution Control District (SJVAPCD).

Number of walk-in vans	21
Commercial pilot period	1/10/2018 - 3/31/2020
Number of months (data collection)	12
Total mileage (mi)	95,618
Average daily mileage per van (mi/day)	35
Availability (%)	95.6%
Fuel economy (kWh/mi)	1.1 - 2.52 kWh/mi
Fuel economy (miles/dge)	18.6 - 48 mpdge
Average moving speed (mph)	37

The goal of this pilot was to evaluate BEV walk-in vans in linen delivery service and demonstrate how the vehicles could meet AmeriPride's business requirements. The BEV walk-in vans that were deployed as

[3] CARB, 2014a. *Final Approved Fiscal Year 2014-15 Funding Plan for Low Carbon Transportation Investments and the Air Quality Improvement Program*. Approved June 26, 2014. http://www.arb.ca.gov/msprog/aqip/fundplan/fundplan.htm.

[4] CARB, 2015c. *Fiscal Year 2015-16 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program*. Approved June 25, 2015. http://www.arb.ca.gov/aqip.

part of this project were used alongside AmeriPride's conventional diesel and gasoline walk-in van fleet. User feedback surveys were administered throughout the commercial pilot to track driver and manager's perceptions over time.

All of the 21 BEV walk-in vans in this commercial pilot were identical in configuration and performance with a range of 70 miles on a single charge. Vehicles were charged using three-phase CS-100-3P chargers manufactured by Clipper Creek.

The AmeriPride BEV walk-in van fleet traveled a combined total of 95,618 miles during the 12-month data collection period of the project. Performance data was recorded using Viriciti data loggers installed by Motiv. This was supplemented by maintenance records provided by Motiv and user satisfaction surveys administered by CALSTART.

AmeriPride routes typically range from 45 - 130 miles. Therefore, the BEV walk-in vans were assigned to service routes to match the vehicle's 70-mile range.

Maintenance data was collected on all BEV walk-in vans during the commercial pilot period by Motiv. The overall fleet availability for the BEV walk-in vans during the data collection period was 95.6%.

By the end of the project, the BEV walk-in vans had an in-motion average fuel economy of 1.11 kWh per mile based on quarterly report data collected by Motiv for the project, which equates to about 42 miles per diesel gallon equivalent (mpdge). However, when including the electricity used to keep the sodium-nickel batteries warm while on standby, the overall energy use of the BEV walk-in vans increased to 2.42 kWh/mile, which reduced the mpdge to 15.7. This value represents a 57% improvement over the 10.79-mpg average of AmeriPride's diesel fleet.

Surveys were used to measure the satisfaction of AmeriPride drivers and managers with the technology. While user acceptance was high among AmeriPride staff, the survey results showed that both drivers and managers did not yet view the BEV walk-in vans used in this pilot as completely satisfactory replacements for their existing non-EV fleet with reliability and range as the primary downsides. Motiv's response time for field service is within 24 hours for this pilot, and all other customer support issues. When asked about converting the entire fleet to electric, a majority of those surveyed did not want to see the entire fleet converted to all-electric propulsion. AmeriPride management was able to achieve some of their business and sustainability objectives ("Targeting a 10% reduction in fuel consumption, or about 16K metric tons of CO^2 through telematics technology, route optimization and modernization of our fleet." [5]) through this pilot project. As a result of the successful pilot, Aramark will be deploying a minimum fifty (50) additional electric walk-in vans from Motiv. Copies of the driver and management surveys are included in Appendix A and Appendix B of this report.

[5] Aramark sustainability initiative: https://www.aramark.com/sustainability/planet/operate-efficiently

LIST OF ACRONYMS

BEV	Battery electric vehicle, a vehicle which is solely powered by an onboard battery
CAN	Controller Area Network
CARB	California Air Resources Board
CPUC	California Public Utility Commission
EVSE	electric vehicle supply equipment
ICE	internal combustion engine
mpdge	miles per diesel gallon equivalent
EPA	Environmental Protection Agency
EV	electric vehicle
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
GVWR	gross vehicle weight rating
KW	kilowatt
kWh	kilowatt hours
LCFS	Low Carbon Fuel Standard
M/HD	Medium-/heavy-duty, refers to vehicles 14,001 – 26,000 lbs GVWR (medium duty) or 26,001 and greater lbs GVWR (heavy duty)
OBD	on-board diagnostic system

DEFINITION OF TERMS

Availability: The number of days the walk-in vans are actually available (uptime), divided by the number of days the walk-in vans are available (uptime) plus any time the walk-in vans are not performing (downtime), expressed as percent availability.

Average speed: The average speed of the BEV walk-in vans while driving, not including stops and idle time. This data is collected using data loggers.

Data scrubbing: A series of validation tests to ensure data provided was good and reliable. If any identified inconsistencies could not be reconciled, the data was discarded during this process.

Demand charge: Charges that are levied by electric utilities on their commercial and industrial customers to recover their capital costs for running additional equipment such as peaker plants to meet access demand. They are calculated based on the maximum amount of electrical power (in kW) that the electric walk-in vans draw from the grid during a charging event. Demand charges are generally assessed monthly based on the highest average kW measured in a 15-minute interval during the billing period.

TABLE OF CONTENTS

Chapter 1: BACKGROUND

1.1 Project Overview

In response to the CARB solicitation for Zero-Emission Truck and Bus Pilot Commercial Deployment Projects in 2015, AmeriPride partnered with Motiv, SJVAPCD, and CALSTART to deploy electric walk-in vans for linen delivery service in four cities within the San Joaquin Valley. CARB granted $7,125,515.00 to SJVAPCD, made possible by the California Climate Investments initiative, for the deployment of twenty-one (21) BEV walk-in vans manufactured by Motiv and twenty-nine (29) Level 2 electrical vehicle supply equipment (EVSE) manufactured by Clipper Creek. The Motiv units replaced AmeriPride diesel walk-in vans on linen service routes in the disadvantaged communities of Bakersfield, Fresno, Merced and Stockton. AmeriPride and Motiv contributed a total of $5.8M in match funds for the project. The Green On-Road Linen Delivery Project was the first deployment of this technology by AmeriPride linen service and represented an opportunity for the company to evaluate electric trucks as replacements for their diesel- and gasoline-powered fleet.

By 2018, AmeriPride was ready to launch its electric walk-in van commercial pilot program with the Motiv units being monitored in operation for one year – from January 1 through December 31, 2019. The project was to demonstrate that BEV walk-in vans can be a replacement for diesel walk-in vans in certain select circumstances and may offer some operational cost savings as well as greenhouse gas reductions. Learnings from this study could be applied to other similar duty routes with other markets. The project also provided benefits to the communities where the trucks operate by reducing criteria pollutants and GHG emissions.

Motiv designed a Data Collection Test Plan to measure the vehicle's performance during the 12-month commercial pilot period and then monitored vehicle and engine performance using Viriciti data logging equipment installed during the construction of the trucks. All project trucks were equipped with data recording hardware before delivery to AmeriPride. The data loggers captured all data transmitted by the BEV walk-in van's Controller Area Network (CAN) through the on-board diagnostic (OBD) port. Additionally, the data logger was also capable of recording Global Positioning System (GPS) data through telemetry monitoring hardware. Once the data loggers were installed on the BEV walk-in vans they were able to record and transmit data without further intervention, collecting data when the vehicle was turned on or charging. The data was continuously transmitted through a cellular network and stored securely in the cloud. Data was regularly downloaded to monitor progress and to check for any errors that would require further attention.

During the 12-month commercial pilot period, Motiv measured energy consumption and other performance parameters from the pilot vehicles. CALSTART also monitored the maintenance of the vehicles and conducted driver and manager surveys to evaluate the user satisfaction. Upon completion of the 12-month commercial pilot period, CALSTART analyzed the results in order to quantify the environmental, financial, and operational benefits of BEV walk-in vans which may inform and motivate other delivery companies to adopt BEV walk-in vans.

1.2 Project Rollout

The project organized construction and delivery of the vehicles into two build phases with ten (10) vehicles in each phase. The first set of ten (10) vehicles were initially to be delivered June 2017, and the second set was to be delivered by September 2017. However, due to contracting delays with CARB, the completion of these tasks was amended to be completed by February 2018 and July 2018 respectively. To meet these amended completion dates, Motiv switched body companies from Morgan Olsen to Utilimaster due to a production backlog at Morgan Olsen. The first set of vehicles were delivered to AmeriPride in March 2018 and the second set was delivered in September 2018. In October 2018, the grant agreement was amended to allow for an additional unit to the project. This unit was delivered in May 2019.

Data collection for all vehicles was originally planned to begin October 2017. Due to delays with the contracting process and delays with EVSE installation, the vehicles were not able to all go into service at that time. The agreement with CARB was amended to move this milestone to August 2018. The first twenty vehicles were all delivered to AmeriPride by September of 2018. However, data collection was still not possible by that time due to delays with EVSE installation. CARB approved in April 2019 partial data collection for those vehicles that were currently in service and to add data collection from the other vehicles as they were placed into service. Data collection was gathered from January 2019 through December 2019.

Milestone 3 for the installation of charging infrastructure and EVSE was originally estimated to be completed in July, 2017 with Milestone 8 for the second phase of charging infrastructure and EVSE installation to be completed in April 2017. Due to the delays in contracting and delays with installation of infrastructure at each site, Milestone 3 for the Stockton and Merced site was completed in August 2018 and Milestone 8 was completed in May 2019.

1.3 Changes to the Project

Project changes that were approved by CARB:

- Change from Morgan Olson to Utilimaster as the body supplier.
- Use of remaining EVSE funding to pay for the 21st vehicle.
- First Priority GreenFleet dropped out of the project due to financial reasons. Motiv took over this role and opened their own Stockton Maintenance center to support the project.
- The anticipated project end date listed in the CARB contract was April 1, 2019. However, due to the unanticipated electrical service upgrades needed at three of the four AmeriPride sites, it was amended to extend the project until March 2020.

1.4 Project Execution

Twenty-one (21) electric step vans were delivered to AmeriPride facilities located in the San Joaquin Valley. During the course of this project, all of the sites had EVSE installed to support the operation of the vans. The chart below shows the operational status of the trucks by site location.

Facility Location	Stockton	Merced	Fresno	Bakersfield	First Priority	Total
Step Vans Delivered	4	5	10	2	N/A	21
Step Vans Registered	4	4	10	2	N/A	20
Step Vans in Service	4	4	10	2	N/A	19
Step Vans on Routes	4	2	8	2	N/A	16
EVSE Installed	4	6	12	4	3	29
EVSE to be Installed	0	0	0	0	0	0
EVSE Installation Date	1/10/2018	11/4/2018	6/7/2019	8/11/2018	5/5/2018	N/A
EVSE Installation Costs	$169,211.00	$193,995.00	$578,612.00	$221,342.00	$ 37,810.00	$ 1,200,970.00
EVSE Cost Each	$ 42,303.00	$ 32,333.00	$ 48,218.00	$ 55,336.00	$ 12,603.00	$ 41,413.00

Vehicle Miles Traveled

In total, the project walk-in vans have traveled 95,927 miles since being placed in service, with Stockton and Fresno having the most accrued miles at 33,184 and 34,050 respectively. Average miles traveled for the trucks in Fresno is 3,324 and Stockton is 7,981. AmeriPride vans historically put on about 18,000 - 24,000 miles each year.

Dispatch Reliability/Maintenance Issues

Initially, reliability was a challenge for these early production vehicles. The first vehicles delivered were prone to breakdowns. Software had to be upgraded manually, since no over-the-air (cellular) services were provisioned. Due to long periods of sitting idle waiting for EVSE installation, many of the trucks had to have the 12-volt batteries replaced before they could be charged for service. Other part replacements included new parking brake cable assemblies that needed to be installed and debugging of the powertrain components. Motiv reported that problems early on were caused in some cases by faulty components as well as issues with software integration. The following is a list of items that Motiv had to replace or update in order to improve operational reliability (some items were replaced on multiple trucks):

- Component Replacements
- Battery Replacements (High Voltage)
- Battery Monitoring Interface
- Cabin heater
- Adaptive Power Controller (Bi-directional DC/DC converter)
- Charger
- Encoder cable
- DC/DC converter replacement
- 12V battery
- Coolant Pump
- Data logger computer
- Hydraulic Power Unit
- Auxiliary Motor Control Unit
- Powertrain Control Unit

- Software Updates
- Battery regeneration adjustments
- DC/DC components
- Software upgrades on all High Voltage batteries

There were a variety of maintenance issues, but it appears most problems were fixed with software upgrades. Beyond that, the following quality control issues were identified and incorporated into production methods:

- Repaired power steering fluid leak
- Tightened loose connections (various)
- Fixed connections to Controller Area Network (CAN), motor and battery disconnect unit
- Fixed coolant flow for the charger

According to AmeriPride staff, Motiv has provided good customer support and quickly resolved issues in the field, which resulted in minimal down time.

Range Limitations

In the project narrative, Motiv anticipated that their vehicle would be able to replace AmeriPride's diesel vehicles "one-for-one" allowing them to be retired. Providing enough range for these vehicles has proved to be a big challenge. The vans in this project were not designed to be electric vehicles initially, so there is added vehicle weight from the batteries that might have been eliminated with a "clean sheet" electric design.

With a battery capacity of 127.2 kWh (usable capacity of 101.76), the average range reported in Motiv's beta test was only 70 miles. This limitation has prevented AmeriPride from using EV walk-in vans on approximately 30% of their routes.

Some of the perceived reliability issues with the trucks was due to range limitations and CALSTART has been working with Motiv to determine if there is an upgrade to the existing power train system that could extend the range. The volumetric density of older commercially available sodium nickel batteries in these vehicles is 280 Wh/liter. In contrast, the new proprietary Tesla Model 3 batteries reportedly have a volumetric density of over 800 Wh/liter. Based on the learnings from this project and continuous technology advancements, Motiv now utilizes BMW lithium-ion batteries, which provide a range of 100+ miles for these BEV walk-in vans.

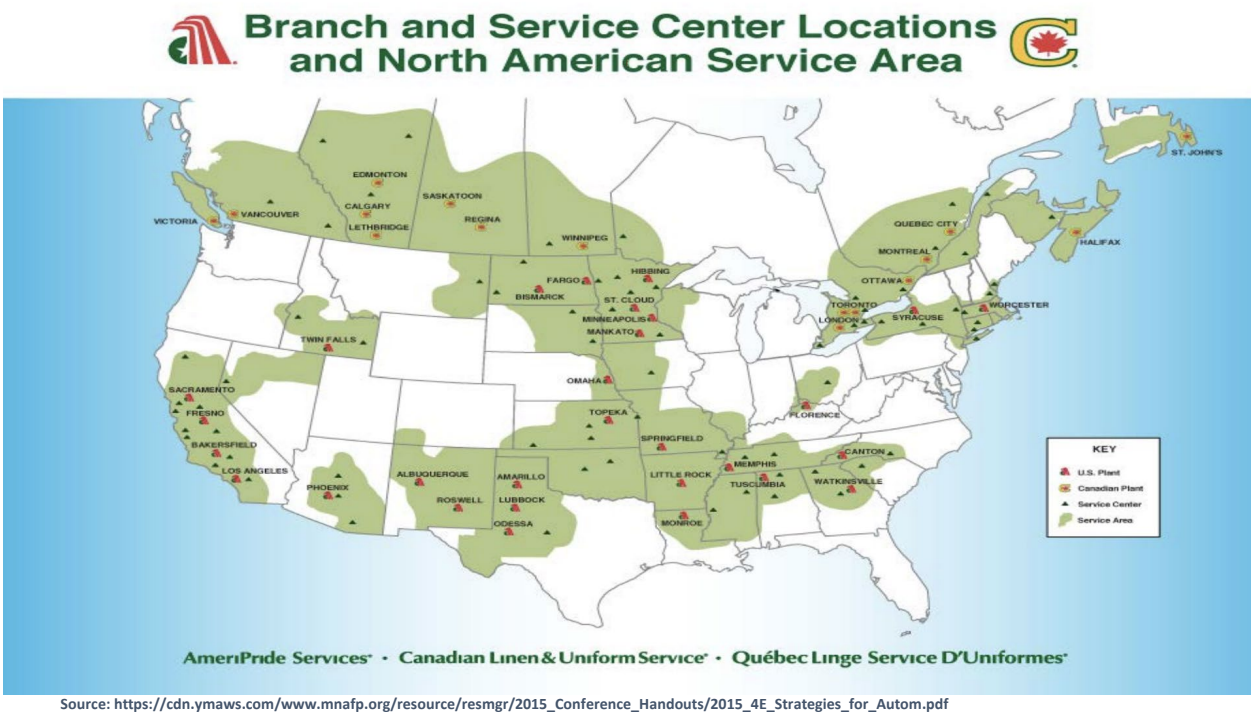
Driver Training

Each AmeriPride driver assigned to drive an electric walk-in van was provided with training. The training materials were provided by Motiv and covered how to safely and efficiently operate the electric walk-in van during service which includes start-up procedures, description of dashboard controls and gauges, and the procedures for charging the vehicle. The training materials can be seen in Appendix D: Motiv Training Materials.

Chapter 2: SERVICE AREA

2.1 Map and Description

As part of its continent-wide service area, AmeriPride serves a growing population in the San Joaquin Valley, with locations in Stockton, Merced, Fresno and Bakersfield. AmeriPride only uses class 6 walk-in vans for all their delivery routes. In central California, Class 8 tractors bring linen from each facility to the main Fresno facility where linens are laundered. Drivers typically operate five days a week between 6:00 am and 8:00 pm.



Source: https://cdn.ymaws.com/www.mnafp.org/resource/resmgr/2015_Conference_Handouts/2015_4E_Strategies_for_Autom.pdf

2.2 Route Profiles

AmeriPride service routes range from 45 - 130 miles per day. See Appendix C for a detailed service route map for each vehicle.

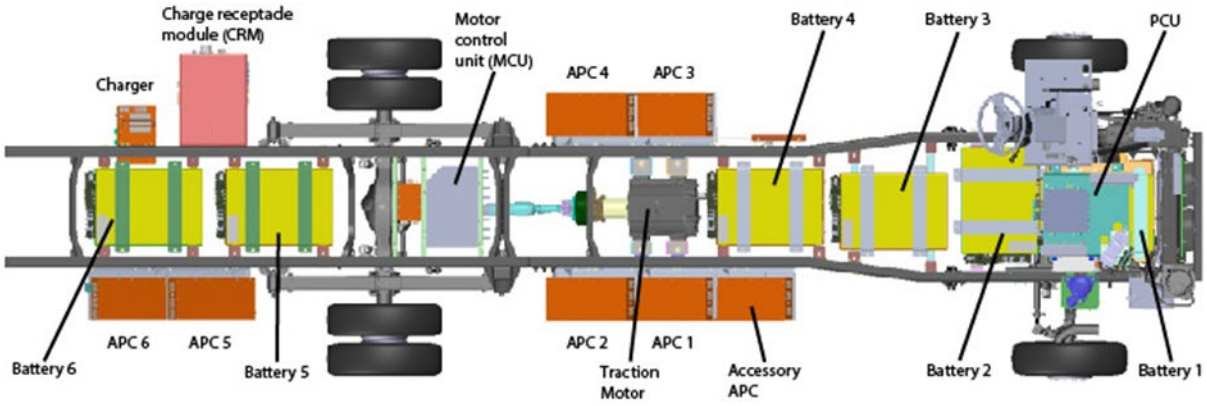
Chapter 3: DEPLOYMENT AND INSTALLATION

3.1 Vehicles

3.1.1 Vehicle Descriptions

AmeriPride deployed and operated twenty one (21) BEV walk-in vans manufactured by Motiv. The six 21.2 kWh FZSonick battery packs are all located under the walk-in van in the chassis, leaving the interior open for cargo. A diagram of the battery locations is shown in the following figures provided by Motiv.

Source: FZSoNick



Source: Motiv

3.1.2 Vehicle Deliveries

The ordering and construction of the trucks for the project was routine and comparable with internal combustion powered trucks of the same size once the subcontracting was completed. However, there were significant delays with the installation of EVSE at three of the four AmeriPride sites, primarily due to long lead times required by the service planning divisions of the electric utilities for engineering and equipment installation. The upgrades needed for each site included new transformers, switching gear, and new service panels. At the Fresno site, there was also the need to remove and replace the

connection to the entire plant site and upgrade with new transformer, pole removal, and new underground connections. Further delays were encountered with the electrical upgrades due to an unusually wet winter and spring in the San Joaquin Valley which stopped work due to rain.

The first chassis began shipping from Motiv to Utilimaster in February 2018. Motiv installed some electric drivetrains in Foster City, while others were installed by Rousch in Livonia, Michigan. After upfitting, vehicles were shipped to Utilimaster for body integration. First Priority GreenFleet then received the complete vehicle in Stockton for final staging and pre-delivery inspection. The first completed vehicles were delivered to AmeriPride's Stockton facility in early 2018, and the last of the fleet was delivered to its Fresno location by September 2018. The 21st vehicle was produced and will be branded as Aramark, but has not yet been registered and placed into service. AmeriPride is currently looking into finding a route for the 21st vehicle, possibly at an Aramark facility located in the San Joaquin Valley, in a disadvantaged community.

At the Stockton site, vehicles were placed into service soon after EVSE installation was completed. At the three other sites, utilization of the vehicles on routes has been slow. A good number of routes are close to the maximum range of the vehicles and local management has been reluctant to use them because they feel there is no margin for error. Due to this range anxiety, it has taken longer than expected for these vehicles to be placed on service routes. Motiv has worked diligently to assuage AmeriPride feelings of range anxiety. Motiv has made several software updates to increase the range of the vehicles, but this has not been able to materially increase the range of the vehicle. Additional training by Motiv engineers is helping drivers to get maximum utilization from the vehicles. With these efforts and pressure from national level staff at AmeriPride, a majority of the vehicles are now in service.

3.2 EVSE

3.2.1 Charging Equipment Description

AmeriPride's BEV walk-in vans were charged by three-phase CS-100-P EVSE manufactured by Clipper Creek using Meltric connectors.

3.2.2 Sites and Installation

Stockton Facility

The installation of the EVSE was relatively straight-forward in Stockton, with work being completed in a reasonable time frame due to the facility having sufficient power available to support the increased electrical load. Stockton has four (4) EVSE installed to support four (4) vehicles.

Stockton EVSE Installation

Stockton EVSE Installation

Merced Facility

In Merced, an additional transformer was required to support vehicle charging, causing some delay. There were additional delays while AmeriPride waited for the landlord to vacate the necessary space for the EVSE. A total of six (6) EVSE were installed for five (5) vehicles.

Merced Pad-mounted Transformers

Fresno Facility

In Fresno, EVSE installation was delayed by a year due to AmeriPride management's extensive deliberation regarding power needs for the facility as well as the added load of the ten (10) new vehicles. Since Fresno serves a large geographic area, this decision was viewed as critical to the organization's growth strategy. The Fresno facility provides cleaning services for AmeriPride locations in Paso Robles and Salinas in addition to the locations that are a part of this project. The upgrades at Fresno were also complicated by an unusually wet winter and spring with infrastructure work on the project being delayed by rain. The Fresno site now has a total of twelve (12) EVSE installed; two (2) in the shop building and ten (10) in the parking lot to support the ten (10) vehicles deployed there. The two (2) EVSE in the shop were originally installed to assist in getting the vehicles running so that they could be registered and that two (2) vehicles could be placed into service while awaiting the completion of the remaining EVSE. The Fresno site is available to Motiv's technicians who are able to perform service on these vehicles directly on site.

Fresno EVSE Installation

Fresno Pad-mounted Transformers

Bakersfield Facility

The Bakersfield site also required extensive electrical service upgrades including a new transformer, switching gear, and electrical panel. This site also experienced delays with getting infrastructure work completed by the electric utility. A total of four (4) EVSE were installed at the Bakersfield location for the two (2) vehicles based there. It was originally anticipated that four (4) vehicles would be deployed here. However, it was decided that due to the longer routes at this facility that initially only two (2) of the vehicles would be placed into service at the Fresno site.

Bakersfield EVSE Installation

Bakersfield Pad-mounted Transformers

3.2.3 Costs

At $41k per EVSE, the infrastructure costs were relatively high compared to other projects. This is due in large part to the fact that transformers had to be installed to bring in more power to most of the facilities. Atlanta-based Chateau Energy Solutions installed most of the EVSEs, but did not provide a detailed cost breakdown with their invoices. The EVSE installation dates shown are the dates in which the EVSE were first energized.

	Stockton	Merced	Fresno	Bakersfield	First Priority	Total
EVSE Installation Date	1/10/2018	11/4/2018	6/7/2019	8/11/2018	5/5/2018	
EVSE Installation Costs	$ 169,211	$ 206,037	$ 578,612	$ 221,342	$ 37,810	$ 1,213,012
EVSE cost each	$ 42,303	$ 34,340	$ 48,218	$ 55,336	$ 12,603	$ 41,828

This installation was more forward looking in anticipation of adding more BEV walk-in vans, since the initial fleet has only used about 44 kWh per day per vehicle on average so far.

Initially, three chargers were installed at the First Priority GreenFleet location in Stockton for the service of these vehicles. However, after First Priority GreenFleet cancelled service with Motiv and closed down their Stockton facility, the three chargers were removed and returned to Motiv. Motiv has since re-installed the chargers at their new service facility in Stockton.

4. DATA COLLECTION

During the 12-month commercial pilot period Motiv measured energy consumption, energy efficiency, and other performance indicators from the BEV walk-in vans using Viriciti data loggers installed on the fleet. Motiv also kept maintenance and service logs for the fleet. Lastly, CALSTART conducted a survey of AmeriPride drivers and management to gauge user satisfaction. The data collected as part of this project provides a comprehensive view into the performance, operation, and maintenance of battery BEV walk-in vans in service for this pilot project.

4.1 Telematics Equipment

All Motiv walk-in vans were equipped with Viriciti data loggers that were used to track vehicle performance and provide telematics. Motiv installed the data logger hardware that records vehicle data from in-vehicle networks and on-board diagnostic sensors. Data was uploaded and stored in secure cloud servers.

4.1.1 Parameters Collected

Motiv used the Viriciti loggers installed on their vehicles to collect the following information:

Parameters Collected	Values Calculated for Reports
Charge Cycles	Daily NOx
Time Charging (delta value)	Daily PM10
Energy Charged	Daily ROG
Distance Driven	Daily CO2e
ODO (odometer)	Qtr NOx
Average Route	Qtr PM10
Average Speed	Qtr ROG
	Qtr CO2e
	Annual NOx
	Annual PM10
	Annual ROG
	Annual CO2e

4.1.2 Data Scrubbing and Validation

Before the data was analyzed, Motiv performed a series of validation tests to ensure the data was accurate and within reasonable limits. If any identified discrepancies could not be reconciled, the data was discarded during a process called “data scrubbing”.

4.2 Operations and Maintenance Data

Motiv's recently opened facility in Stockton now provides maintenance support to Aramark's vehicle fleet in addition to the onsite support provided by Motiv's technicians.

4.2.1 Maintenance Events

Motiv kept a log of the maintenance performed on each of the walk-in vans during the evaluation period, and is summarized below.

LOCATION	VEHICLE	MAINTENANCE FOR CRITICAL ISSUE (SERVICE DATE)	MAINTENANCE FOR NON-CRITICAL ISSUE AND UPGRADES (SERVICE DATE)
Bakersfield	MVN2016	•Charger failure - R&R charger (8/20)	•Installed multi-header 12V battery terminal (9/13) •12V terminal posts (12/20)
	MVN2023	--	•Installed multi-header 12V battery terminal (9/13) •Replaced 12V battery (12/26)
Stockton	MVN2022	--	•Shutters/hesitates upon acceleration - upgraded SW on all components (1/13) •Installed upgraded brake cable kit & upgraded vehicle software (8/14) •11/7 Charger failure - R&R charger
	MVN2026	•Replaced battery management FZ component (2/21)	•Check engine light (CEL) - upgraded SW on all components (1/30) & (2/7) •Installed upgraded brake cable kit & upgraded vehicle software (8/14) •Vehicle will not go into gear - R&R HV battery and BMI (12/5)
	MVN2027	--	•Vehicle will not go over 40MPH - reset battery fault (2/11) •Installed upgraded brake cable kit & upgraded vehicle software (8/14) • CEL - R&R APC (10/25) • CEL - R&R HV battery (12/18)
	MVN2032	•Charger failure - replaced 12V battery, reconfigured charger (7/2) • Vehicle offline - Upgrade vehicle software, R&R charger (7/9) •Loss of power - R&R 12V battery (9/23)	•Installed upgraded brake cable kit & upgraded vehicle software (8/14)
Merced	MVN2024	•Died in service - tightened 12V terminal (1/3) •Battery isolation fault - replaced high voltage battery (2/18)	•No power steering - R&R AMCU (11/12)

Merced	MVN2030	•HV battery internal isolation fault - R&R HV battery (7/10) •Driveline vibration - in the queue for support (11/21)	•Installed upgraded brake cable kit & upgraded vehicle software (8/8)
	MVN2034	•APC Failure - replaced APC (1/2) •CAN Issue - configure APC and reset battery node (1/8) •DC/DC failure - replaced DC/DC (1/22) (4/1) • HV battery internal isolation fault - R&R HV battery (7/10) •Check engine light - Secured the positive HV cable (7/29)	•Installed upgraded brake cable kit & upgraded vehicle software (8/8) •No power steering - R&R AMCU (12/5)
	MVN2035	•HV Battery failure - replaced battery(1/2) •Check engine light (CEL) - upgraded SW on all components (2/18) •Charger failure - R&R charger(7/2)	--
	MVN2074	No route assigned	
Fresno	MVN2017	--	• Installed wheel well liner (9/27)
	MVN2018	• Check engine light - R&R APC, update vehicle software (8/5)	•Installed multi-header 12V battery terminal (9/9)
	MVN2019	--	•Installed multi-header 12V battery terminal (9/9) • Installed wheel well liner (9/27) • Melted multi post battery terminal - R&R terminal (12/27)
	MVN2020	•Loss of power - R&R HPU and AMCU (7/21)	•Installed multi-header 12V battery terminal (9/9) •Leaking coolant under the hood - R&R coolant line (10/30)
	MVN2021	•Inverter failure - R&R and configured drive motor inverter (7/22) • Coolant pump failure - R&R coolant pump (8/9)	•Installed multi-header 12V battery terminal (9/9)
	MVN2025	•Lost power steering - Installed new HPU pulley and the drive belt (8/9)	--
	MVN2028		•Installed multi-header 12V battery terminal (9/9) • Installed wheel well liner (9/27)

Fresno	MVN2029	•HV battery internal isolation fault - R&R HV battery (8/1) •Loss of power - Tightened 12V terminal (8/22) •Dead vehicle - R&R 12V battery (8/26)	--
	MVN2031	•HV battery fault - R&R HV battery (7/29) •HV battery overheated - R&R HV battery	•Installed upgraded brake cable kit & upgraded vehicle software (8/5) •Installed multi-header 12V battery terminal (9/9) •Charging issue - R&R DC/DC cable (11/19)
	MVN2033	•Motor drum spline found stripped - R&R brake drum on the motor (8/6)	•Installed multi-header 12V battery terminal (9/20) •Noise while driving - R&R gear brake drum (11/15)

4.3 User Acceptance

4.3.1 Driver Evaluation Surveys

Drivers were asked to complete a survey at the end of the pilot project by indicating their level of satisfaction with the BEV walk-in vans as compared to their baseline diesel fleet. CALSTART only received 3 responses from AmeriPride drivers not enabling statistically significant conclusions. The survey results are shown in Appendix A.

4.3.2 Management Evaluation Surveys

AmeriPride management was asked to complete a satisfaction survey. CALSTART received 8 responses from AmeriPride management. The survey results are shown in Appendix B.

5. ANALYSIS

The large volume of data that Motiv collected using data loggers during this project was analyzed to understand how the BEV walk-in vans were utilized, how they charged, and how they consumed energy.

5.1 Vehicle Performance

The following tables illustrate how the BEV walk-in van fleet performed throughout this project. CALSTART relied upon the data reports submitted by Motiv. There were some inconsistencies between the reports, and are noted below. Average monthly miles traveled per vehicle was calculated using the sum of the individual quarterly data mileage amounts reported by Motiv, divided by the 20 vehicles actually in service, divided by 9 months of the pilot duration. Average daily mileage was calculated by dividing the average monthly mileage by 21.67 working days per month.

5.1.1 Vehicle Profile and Mileage

			In Service Data	Prior	Q2	Q3	Q4	Total Miles
1	Bakersfield	MVN2016	5/1/2019	203	681	1,325	1,008	3,217
2		MVN2023	4/9/2019	1,179	1,786	1,879	2,144	6,988
3	Stockton	MVN2022	2/23/2018	5,862	2,311	2,747	1,004	11,924
4		MVN2026	1/30/2018	5,917	474	776	1,033	8,200
5		MVN2027	2/9/2018	1,870	405	528	1,862	4,665
6		MVN2032	1/30/2018	4,387	1,290	444	2,274	8,395
7	Merced	MVN2024	8/20/2018	2,859	1,797	1,763	1,749	8,168
8		MVN2030	8/20/2018	226	73	384	384	1,031
9		MVN2034	8/20/2018	748	78	142	10	978
10		MVN2035	8/20/2018	1,935	1,829	1,877	2,332	7,973
		MVN2074	Not yet registered	338				338
11	Fresno	MVN2017	5/20/2019	105	48	1,629	2,208	3,990
12		MVN2018	5/20/2019	23	173	2,070	2,790	5,056
13		MVN2019	5/20/2019	155	48	1,006	745	1,954
14		MVN2020	5/23/2019	4	90	696	918	1,708
15		MVN2021	7/31/2019	10	74	821	1,660	2,565
16		MVN2025	6/11/2019	31	98	1,817	2,402	4,348
17		MVN2028	5/8/2019	950	629	1,924	2,345	5,848
18		MVN2029	6/10/2019	9	83	1,177	2,525	3,794
19		MVN2031	6/12/2019	24	95	333	0	452
20		MVN2033	5/22/2019	320	414	1,811	1,790	4,335
	TOTALS			**27,155**	**12,476**	**25,149**	**31,183**	

Average monthly miles traveled per BEV walk-in van: 413 miles.
Average daily miles traveled per BEV walk-in van: 35 miles.

Average Speed

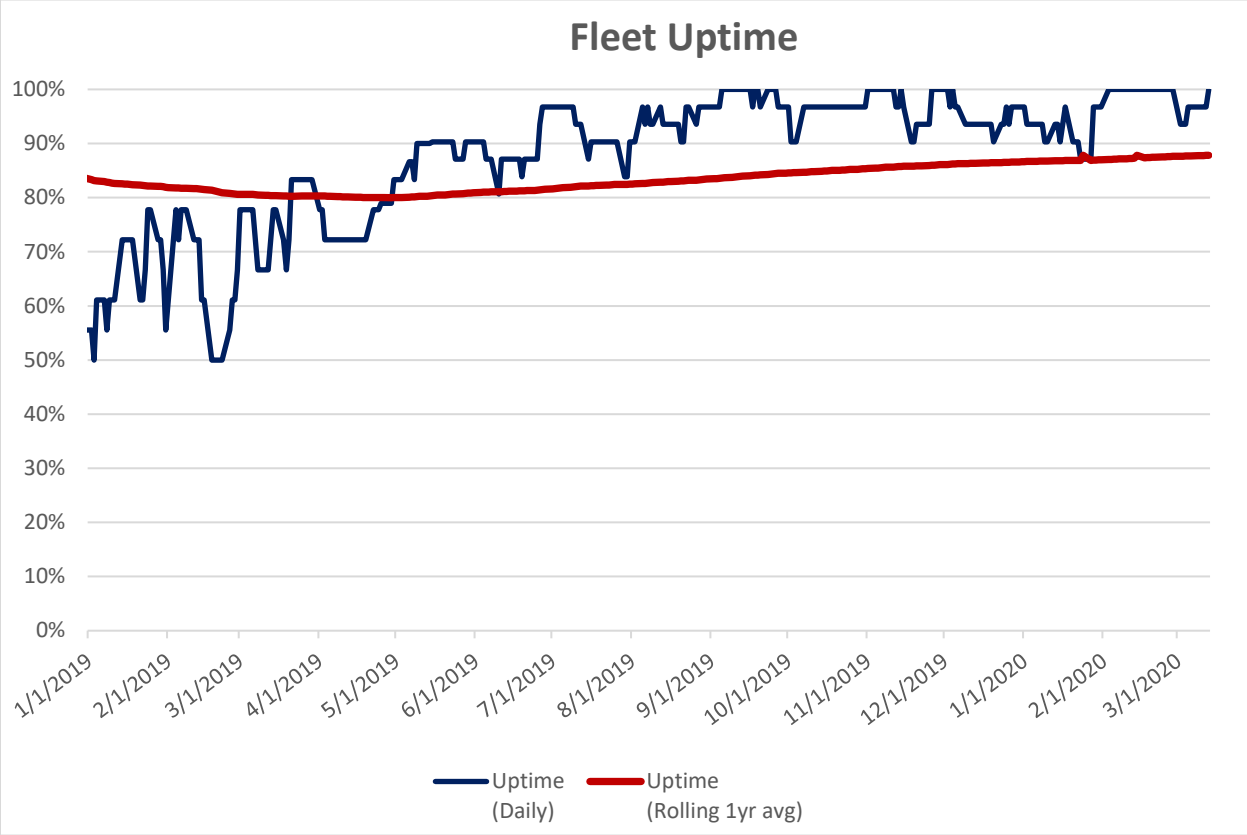
Q2	57	mph (per Motiv)
Q3	31	mph (per Motiv)
Q4	23	mph (per Motiv)
3 Quarter Average	37	mph

5.1.2 Availability and Reliability

Motiv has reported that their vehicle uptime percent has increased over time. This trend is consistent with CALSTART's observations.

	Location	Uptime (%)	Qty	Weighted Avg	
Q2	Fresno	90%	10	9	Per Motiv
	Bakersfield	100%	2	2	Per Motiv
	Stockton	98%	4	3.92	Per Motiv
	Merced	87%	5	4.35	Per Motiv
	Overall	**91.8%**		19.27	Calculated Total
Q3		**97.0%**	Per Motiv		
Q4		**98.0%**	Per Motiv		
3 Quarter Avg		**95.6%**			

Fleet uptime



The down days taken in account were only days the vehicles were out of service for powertrain related issues. There were times the vehicles missed routes because the drivers forgot to charge the vehicles after their route, resulting in low state of charge for the next day. These do not count as down days.

- Majority of Motiv's vehicles had more than 90% uptime each.
- A technician arrives on site on average within 1 day after getting a call from the customer.

5.1.3 Vehicle Efficiency

Motiv has reported overall vehicle efficiency as well as vehicle efficiency while in motion. Vehicles appear to have become more efficient over time, perhaps due to software improvements and driver efficiency.

However, when considering overall performance, kWh consumption per vehicle appears to have increased over time, suggesting that other factors may have been involved. It is possible that unseasonably low winter temperatures contributed to the higher kWh consumption needed to keep batteries warm, since most BEV walk-in vans were stored outdoors.

Q2	Miles driven	11,995	Per Motiv	
	kWh used	18,275	Per Motiv	
	Efficiency	incl. standby kWh	0.66	mi/kWh
			1.52	kWh/mi
			24.9	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
		excl. standby	1.40	kWh/mi (per Motiv)
			53.1	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
Q3	Miles driven	26,487	Per Motiv	
	kWh used	66,651	Per Motiv	
	Efficiency	incl. standby kWh	0.40	mi/kWh
			2.52	kWh/mi
			15.1	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
		excl. standby	1.13	kWh/mi (per Motiv)
			42.9	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
Q4	Miles driven	31,166	Per Motiv	
	kWh used	75,495	Per Motiv	
	Efficiency	incl. standby kWh	0.41	mi/kWh
			2.42	kWh/mi
			15.7	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
		excl. standby	1.11	kWh/mi (per Motiv)
			42.1	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
3 Quarter Avg	Efficiency	incl. standby kWh	**0.49**	mi/kWh
			2.15	kWh/mi
			18.6	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*
		excl. standby	**1.27**	kWh/mi
			48.0	mpg equivalent (assumes 37.95 kWh per diesel gallon equivalent)*

*Gable, Christine & Scott. "Gasoline Gallon Equivalents (GGE)." ThoughtCo, Feb. 11, 2020, thoughtco.com/fuel-energy-comparisons-85636.

5.2 Operation and Maintenance

AmeriPride reports that the overall operating cost of their BEV walk-in vans has been about 62% lower than their diesel fleet, and about 47% lower than their gasoline-powered fleet. CALSTART notes that these values don't appear to take into consideration the kWhs consumed to keep batteries warm during standby, however, they still represent a significant reduction of the total cost of ownership (TCO) for fleet vehicles.

	Diesel	Gasoline	BEV
Price Per Gallon	$3.08	$2.68	
MPG	10.79	6.02	
Average cost per kWh			$0.18
kWh consumed/mile			1.1
Cost per Mile	$0.29	$0.45	$0.20
Maintenance per Mile	$0.53	$0.14	$0.11
Total Operating CPM	$0.82	$0.59	$0.31
BEV Cost Advantage CPM ($)	$0.51	$0.28	
BEV Cost Advantage CPM (%)	62%	47%	

Source: AmeriPride

5.2.1 Maintenance Cost Comparison with ICE Walk-in Vans

AmeriPride reports that the maintenance cost per mile for their diesel fleet is $0.53/mile, their gasoline fleet maintenance cost per mile is $0.14, and the maintenance cost of their BEV fleet is $0.11 per mile.

5.2.2 Fuel/Energy Cost Comparison with Diesel Walk-in Vans

With an average kWh cost of $.18/kWh, AmeriPride reports that the fuel costs for BEV walk-in vans is considerably lower than their ICE fleet.

5.2.3 Availability and Reliability Comparison with Diesel Walk-in Vans

AmeriPride reports that both their BEV and ICE fleet have now achieved 100% uptime availability.

5.3 User Feedback Surveys

5.3.1 Driver Evaluation Survey Results

Feedback from 3 drivers has been consistent across the different locations. The primary concerns from drivers has been with acceleration and range, making them apprehensive to drive these vehicles to the maximum range limit and on freeways. This does cause issues with the drivers because the majority of routes are at the upper limit of the truck's 70 mile range or longer. For those that have routes that take them on the freeways, the acceleration from 30-60 miles per hour is slower than a comparable ICE truck, so merging onto freeways can be challenging. The top speed is also limited to less than the posted 65 mph speed limit on the freeway. With these challenges, the vehicles seem more suited to lower speed urban area routes.

Drivers also expressed concern about vehicle reliability. Some early stranding problems were caused by component failures and related software issues. In these instances, the AmeriPride site manager delivered a replacement ICE vehicle to the stranded driver, whereupon the driver had to unload the BEV and load the ICE walk-in van. The BEV walk-in van then had to be towed back to the facility. These situations usually resulted in multi-hour delays, causing late deliveries, and making the driver reluctant to drive the EV again. Additional charging infrastructure would greatly alleviate this challenge. Additional charging infrastructure would greatly alleviate this challenge.

Early on, drivers were forgetting to plug in the vehicle at the end of their shifts, which resulted in vehicles not being charged and unavailable the next day. Fortunately, this turned out to be a short-lived problem, and most drivers quickly adopted the habit of plugging in their vehicle at the end of the day vs pumping gas or diesel.

Motiv was very responsive in correcting issues identified by drivers with the early BEV walk-in vans. As a result, the driver-centric culture Motiv has implemented has some drivers jealously guarding their turn to drive the BEV walk-in vans. With the increased reliability, drivers with route lengths appropriate for the electric powertrain have embraced the newer and larger BEVs. Many others would like to drive the BEVs, but it isn't feasible due to the length of their routes. The growing consensus now among the drivers is that BEVs are the future, and more drivers want to make the switch provided the trucks can achieve the range needed for their routes.

CALSTART conducted a satisfaction survey of the drivers at the end of the project (see Appendix A) and based on three (3) driver responses noted that they are still wary of BEVs and didn't yet see them as viable replacements for their ICE fleet. However, since only 15% of driver surveys were returned, these survey results may be prone to non-response bias and not reflect overall driver attitudes.

5.3.2 Management Evaluation Survey Results

With the acquisition of AmeriPride by Aramark, the latter is being lobbied by the AmeriPride team to adopt BEV technology more rapidly. Aramark is a much larger company and represents a significant opportunity to expand the BEV fleet.

AmeriPride management had indicated that if the truck range could be increased to 250 miles, they would be able to replace their entire fleet with BEV walk-in vans. This range increase represents about a 357% improvement from the current 70 mile range. Motiv has considered the possibility of adding a 7th battery, but has determined that it is not feasible. They have also experimented with allowing a 90% depth of discharge to increase range, but this idea was abandoned after it was found to be of minimal benefit. As mentioned earlier, Motiv now utilizes BMW batteries which provide a range over 100 miles.

AmeriPride has been generally happy with their vehicles, especially after the early software and component issues were corrected. As a result of this pilot, and the adoption of BMW batteries by Motiv, AmeriPride/Aramark has recently ordered another 50 BEV walk0in vans for use in California.

CALSTART conducted a satisfaction survey of AmeriPride management, and found that the management is not yet ready to fully embrace BEVs (see Appendix B). They are looking for improvements in range primarily.

5.4 Motiv Feedback

Motiv has shown itself to be a very adaptable and capable company in this project. They had to adapt to delays caused by EVSE infrastructure installation and specifically AmeriPride management's challenges related to the Fresno site electrical infrastructure. As a result, Motiv's production timing did not align with EVSE installations at many of the sites and trucks had to be delivered and sit idle until the EVSE was installed. This situation created challenges since the battery system in the trucks needed to be kept

charged to stay functional. Many of the high voltage batteries in the trucks delivered to sites without functioning EVSE had to be replaced before they could enter service, which resulted in more on-site product support than originally envisioned.

The original plan was to use Stockton-based First Priority GreenFleet to support these vehicles throughout the project, but First Priority GreenFleet suffered some financial setbacks that necessitated Motiv to take over this role.

Prompt and effective service has helped overcome AmeriPride driver concerns about reliability by showing that the company making the powertrain cares about the user experience and is diligent at correcting problems. Motiv has also been proactive in many cases and has provided upgrades to vehicles before problems arose, which further strengthens their reputation with AmeriPride.

5.4.1 Accelerating Commercialization

This pilot project accelerated the adoption of electric walk-in vans by providing AmeriPride a means of more than tripling their fleet from 6 repowers purchased through a CEC grant to a total of 31 vehicles in active service today. AmeriPride has submitted an order for an additional fifty (50) Motiv vehicles, due to their experience gained through this pilot project. The confidence shown in Motiv from AmeriPride increased Motiv's standing in the walk-in van market and helped Motiv become a viable option for other commercial fleets that have since purchased electric walk-in vans from Motiv.

5.4.2 Reducing Manufacturing Costs

Motiv's manufacturing costs were reduced because this project encouraged product standardization which aided in decreasing the chassis upfit time and decreased the amount of engineering inputs for individual vehicle deliveries. Project funds for the vehicle manufacturing milestones were entirely used with project funds remaining for EVSE installation.

5.4.3 Product Improvements

This project improved Motiv's products by bringing a greater focus on reliability. The F-59 EPIC chassis was a relatively new product offering at the beginning of this project. Through the larger number of vehicles being delivered as part of this pilot project, Motiv was able to focus on improving vehicle reliability through software updates and electrical systems improvements. This in turn decreased the number of service visits required and increased vehicle uptime. In addition, the improvements in battery technology and costs have resulted in significant range improvements to Motiv's walk-in vans.

5.4.4 Plans for moving forward

Motiv has continued to increase their product reliability and efficiencies. Motiv's current F-59 BEV walk-in vans now utilize BMW lithium-ion batteries which improve range to over 100 miles. The transition to lithium-ion batteries also negates the need to keep the batteries warm, increasing the overall efficiency of the battery and increasing mpdge.

5.5 AmeriPride/Aramark Feedback

5.5.1 Benefits to AmeriPride/Aramark

The BEV walk-in vans allowed AmeriPride to achieve three (3) separate business objectives that it had outlined prior to moving forward with its green initiative. They are as follows:

- Reduce emissions: AmeriPride has completed this goal through the introduction of BEV walk-in vans with an estimated reduction of 185 metric tons of CO2 (this is not only the 20 EVs from this project, but also includes 10 additional EV step vans in operation in Southern California)
- Control costs: AmeriPride was able to significantly reduce their fuel and maintenance costs with the introduction of BEV walk-in vans into their fleet
- Differentiate AmeriPride: By reducing emissions and costs associated with using fossil fuels, AmeriPride was able to achieve market differentiation that it was then able to use in marketing campaigns, vehicle signage, and corporate responsibility reporting.

5.5.2 AmeriPride's Lessons Learned and Future BEV Deployment Plans

According to AmeriPride's management, in order for them to electrify their entire fleet they would need the following to happen:

- BEV walk-in vans range needs to increase to approximately 250 miles.
- Additional maintenance providers would need to be trained and willing to work on BEV vehicles
- Charging infrastructure needs to be built at little to no cost to the end user; the massive cost of infrastructure is prohibitive for future expansion.
- In addition to the cost of the infrastructure, utilities must make the process for transformer/grid upgrades much easier. In Fresno, the transformer design, approvals and installation took nearly 2 years to complete.
- BEV walk-in vans need to be the same cost as ICE vehicles either through incentives or market competition.

6. CONCLUSION AND LESSONS LEARNED

6.1 Lessons Learned

6.1.1 Findings

The pilot project has produced many learnings that have already been valuable as new projects have been implemented using CARB funding. The listing below describes some of the original plans of the project team, how those ideas had to be revised, and the lessons learned for future projects.

EVSE Installation

Issue #1: Excessive EVSE installation budget.

The original $1.4M budget allocation to deploy the 29 EVSE to support the BEV walk-in vans ($48k per EVSE) was too high so some of these funds were reallocated to pay for a 21st vehicle. Even with this reallocation of funds, there still was enough funding to install transformers at three (3) of the four (4) sites. It is assumed that the reason for the infrastructure upgrades was to enable full fleet electrifications when additional vehicles become available.

Lesson Learned: Medium and heavy duty EVSE installation needs careful early planning and engineering to ensure appropriate funding is allocated. Project developers should engage an electrical contractor or engineer early in the project to evaluate the potential sites for EVSE installation to understand if the facility can handle the added electrical load. This evaluation should also consider the electric utility capacity and if utility level upgrades are going to be required as part of the project and what those upgrades will cost and how they will take to implement.

Issue #2: Excessive wait times for EVSE installation.

AmeriPride experienced significant delays with the EVSE installation, ostensibly because of some negotiations that took place between AmeriPride and PG&E. Additionally, there were some delays with PG&E scheduling work necessary to bring in additional power to three of the sites. The Fresno site was the largest, and was the most severely impacted.

Lesson Learned: Medium and heavy duty EVSE installation needs careful early planning and engineering to ensure appropriate timelines are established. Project developers should engage an electrical contractor or engineer early on to evaluate the potential sites for EVSE installation and to clearly understand power needs and the time required to bring in additional power if necessary. This evaluation should also consider the electric utility capacity and if utility level upgrades that may be required as part of the project and how much time it will take for work to be scheduled and completed.

Electric Vehicles

Issue #3: Vehicles did not perform as well as expected.

The expectation was that the BEV walk-in vans would be a one-for-one replacement of AmeriPride's ICE fleet. In reality, the BEV walk-in vans were only suitable for the shortest routes due to their limited range. AmeriPride drivers are continually encouraged to add length to their routes, and as a result, successful drivers "outgrow" their BEV walk-in vans over time and have to switch back to an ICE walk-in van when they achieve higher levels of success. Additionally, facility managers find it economically advantageous to hire fewer drivers and assign longer routes. Both of these factors result in many routes that are too long to be serviced by the BEV walk-in vans.

Lesson Learned: Potential sites for deployment of BEVs need to be evaluated carefully prior to selection for fitness of use. The business needs of AmeriPride run counter to the capabilities of the BEV walk-in vans to some degree, limiting their utility. Motiv has indicated that there was not room to add a seventh sodium nickel battery Through software updates, Motiv engineers tried to increase range by enabling a 90% depth of discharge, which yielded an increased range of about 10 miles under ideal, unloaded conditions. Motiv's latest BEV walk-in vans which utilize BMW batteries will improve range.

Issue #4: Vehicles were prone to break-down and experienced reliability issues after delivery.

Soon after initial deployment, the BEV walk-in vans suffered from component failures, quality control issues, and the need for software updates that resulted in considerable downtime and reliability issues. This created an impression early in the project with drivers and maintenance staff at the AmeriPride sites that the BEV walk-in vans were not as reliable and did not perform as well as the conventional walk-in vans they were designed to replace.

Lesson Learned: BEV walk-in vans that use new technology should be thoroughly tested before delivery to the end-user to avoid the perception they are inferior to ICE vehicles due to early development issues being unresolved. “First articles” or “sample units” need to undergo extensive reliability and endurance testing at recognized testing facilities such as TRC (http://www.trcpg.com/) before production units are built. While this would potentially add more cost to production of new designs, it would provide assurance for the end-user that the vehicle performance will meet their requirements and the systems have been tested for reliability before the first units arrive for service. This approach is similar to what the Federal Transit Administration (FTA) requires for new transit bus manufacturers before their products are eligible for Federal funding. FTA requires Altoona testing of new transit buses to protect transit agencies from receiving bus products that don’t perform and/or have a high failure rate in service. A similar testing for new BEVs would benefit the fleet customers by providing them with some type of certification that the new vehicle product has been tested and passed an objective testing program that validates performance.

Issue #5: Local vehicle support was needed from the beginning.

In the initial pilot project design, Motiv had planned to contract with a local firm in Fresno County to provide support for their drive-train system once the vehicles were delivered and placed in service.

In practice, the local firm Motiv had planned to use ceased operations soon after the trucks were delivered, forcing Motiv to provide product support services from their facilities in the Bay Area. Motiv stepped up to this challenge and provided very good support for their vehicles. Motiv recognized the need for local support of this new technology and as a result has recently opened a new maintenance facility in Stockton.

Lesson Learned: Early deployments of electric medium and heavy-duty vehicles require local maintenance and product support to address the inevitable technology “teething” problems that are associated with new products in order to build up the confidence with fleet managers. Almost all drivers and managers have reported experiencing at least one breakdown incident. Future pilot projects should be centered around established local support networks for the technology provider until the technology is more mature and widespread. Using this criteria, future project development will leverage investment made by technology providers through early vehicle deployments and provide a greater opportunity for successful acceptance by the end user.

6.1.2 Conclusions

This project showcased important technology developments for electric medium and heavy duty vehicles. While these vehicles did not directly match the performance of the vehicles they would be replacing, the deployed vehicles are evidence that progress is being made towards this goal.

7. AmeriPride Future Intent

7.1 Maintaining and Growing the Fleet

AmeriPride management has stated that in order to convert their fleet to all-electric vehicles, they would need to see the range increased to at least 250 miles. This represents an increase of around 357%, so we are not likely to see this happen for several years until battery volumetric density improves. However, based on this pilot, and the greater range of the latest Motiv vehicles, AmeriPride has recently

placed an order for an additional 50 BEV walk-in vans to be deployed in California. In addition, AmeriPride appears willing to continue utilizing their BEV walk-in vans for the foreseeable future. The operational cost savings are fairly significant, even if you factor in the cost of maintaining battery temperatures while on standby. As utilization increases and idle time decreases, the standby kWh consumption should be reduced.

7.2 Further BEV Deployments

AmeriPride was acquired by Aramark during this project. The AmeriPride management has expressed their desire to encourage Aramark management to consider migrating their much larger fleet to BEV walk-in vans. This upgrade is most likely to occur in California, where HVIP subsidies may be available. The recent order by the company shows its commitment in reaching their sustainability goals and trust in Motiv's technology and service to help them reach it.

Appendix A: Driver Satisfaction Survey

(Attached by separate file)

Appendix B: Management Satisfaction Survey

(Attached by separate file)

Appendix C: AmeriPride Service Route Maps

(Attached by separate file)

Appendix D: Motiv Training Materials

(Attached by separate file)

Appendix E: Motiv User Manual

(Attached by separate file)

Appendix F: Motiv Customer Reports

(Attached by separate file)