Pilot Heavy-Duty Electric Vehicle (EV) Demonstration for Municipal Solid Waste Collection

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Municipality of Anchorage Solid Waste Services (SWS)
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Project ID: TI139

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Overview

Timeline

- Start: October 1, 2020
- End: December 31, 2025
- 38% Complete

Budget

- Total project funding:
  - DOE share: $689,659
  - Cost share: $1,288,909
- Total project expended:
  - DOE share: $26,632.19
  - Cost share: $567,826.32

Barriers Addressed

- Cold climate performance of medium and heavy-duty electric vehicles
- Battery integration to shave peak demand charges
- EV workforce development

Partners

- Alaska Energy Authority
- Alaska Center for Energy and Power
- eCamion, Inc.

Project Objectives

Objectives

- Acquire and integrate two 520 electric garbage trucks and a 220 electric box truck
- Install battery-tied EV Servicing Equipment (EVSE); program for optimized charging times for both heavy duty EVs
- Collect and analyze data from integrated software
- Provide project data to local and statewide fleet managers
- Compare performance to manufacturer claims and document in quarterly reports
- Offer private demonstrations, test drive opportunities, and reporting of lessons learned, best practices, and case studies to fleets in Anchorage and beyond

VTO TI Goals

- Improve fuel diversity
- Increase local resiliency
- Reduce greenhouse gas emissions

Impact

- Demonstrate cold climate performance of medium and heavy duty electric vehicles
- Integrate battery for peak shaving
- Future proof new construction for EV integration

Any proposed future work is subject to change based on funding levels

Project Approach

Initiate pilot deployment

- Extensive research and discussions to identify the most appropriate technology and vendors, considering our remote location, cold climate, and operational needs
- Acquire and install equipment
- Begin equipment integration
- Prepare for data collection and analysis

Monitor pilot deployment

- Performance assessment of EVs and EVSE with a focus on cold climate operation
- Assess battery supported EVSE performance and applicability
- Offer project data and demos to local and statewide fleet managers
- Compare fuel use of EVs to diesel vehicles; calculate savings and carbon reduction

Continued equipment maintenance

- Continued fleet outreach
- Create performance assessment summary
- Calculate and share carbon and fuel use of EVs and EVSE

Go/No-Go Decision Points

Equipment received and tested

Duty cycle and minimum uptime requirements met

Final Report Developed and Distributed

Project Approach: Milestones

Budget Period 1

Milestone	Type	Description
All equipment received	**Technical**	**The recipient takes delivery of both heavy-duty EVs and EVSE**
EVSE installed	Technical	Battery-tied EVSE has been installed and tested. Final programming has been completed to optimize charging times for both heavy-duty EVs.
Equipment Operation Initiated	Technical	Charging of heavy-duty EVs with battery-tied EVSE successful. Waste collection and cart delivery begins using heavy-duty EVs
Data Collection and Analysis Implemented	Technical	Data collection from heavy-duty EVs and EVSE begins using installed equipment and integrated software. Analysis begins and quarterly reporting begins.
Equipment received and tested	Go/No Go	All equipment has been received and has been confirmed to perform to specification.

Budget Period 2

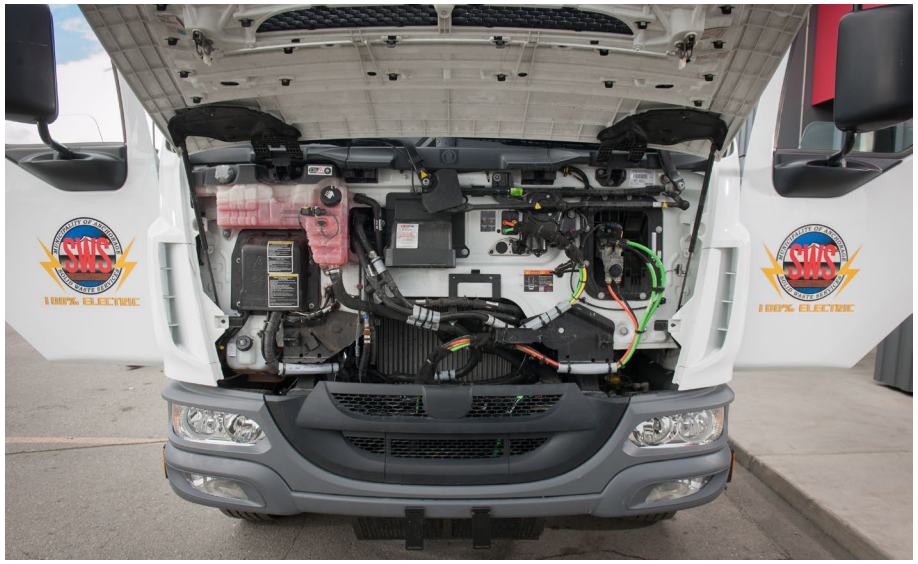
Milestone	Type	Description
Performance Assessment of EVs and EVSE Continued	**Technical**	**Coordinate the collection and analysis of data and produce quarterly analysis reports**
Fleet Outreach	Technical	Provide project data to local and statewide fleet managers.
Fleets provided with personal demos	Technical	No less than five fleet managers provided with personal demonstrations of the equipment
Analysis Reports Prepared	Technical	Compare performance to manufacturer claims and document in quarterly reports
Duty cycle and minimum uptime requirements met	Go/No Go	The EVSE and heavy-duty EVSE meet all duty cycle requirements and achieve a minimum 90% uptime rating

Budget Period 3

Milestone	Type	Description
Performance Assessment of EVs and EVSE Continued	**Technical**	**Coordinate the collection and analysis of data and produce quarterly analysis reports**
Fleet Outreach Continued	Technical	Provide project data to local and statewide fleet managers.
Fleets provided with personal demos	Technical	No less than five fleet managers will be provided with personal demonstrations of the equipment
Final Report Developed and Distributed	Technical	A final report will be compiled for the project with in-depth written analysis and summarizing lessons learned from this project.

Any proposed future work is subject to change based on funding levels

Project Accomplishments and Progress



The hood interior of the 220 electric vehicle box truck

Residents looking at the SWS Peterbilt 220e box truck at the Anchorage Electric Vehicle Car Show, August 2021. Photo: Tim Leach

Task 1: Initiate Pilot Deployment	**Completion:**
• Acquire and install equipment	Partial
• Begin equipment integration	Partial
• Prepare for data collection and analysis	Complete

Task 2: Monitor Pilot Deployment	
• Performance assessment of EVs and EVSE	Partial
• Quarterly assessment and reporting	Ongoing
• Offer project data and demos to local and statewide fleet managers	Partial
• Equipment Maintenance	Ongoing
• Compare fuel use of EVs to diesel vehicles; calculate savings and carbon reduction	Incomplete

Previous accomplishments include receiving the 220e box truck and displaying at the Anchorage Electric Vehicle Car Show August 2021. Presented during 2021 AMR.

Any proposed future work is subject to change based on funding levels

Project Accomplishments and Progress Cont.

The eCamion battery pad was installed in the new facility as well as two charging stations inside the warm storage.

eCamion installed Electric Vehicle Servicing Equipment (EVSE) at the new SWS Transfer Station, November 2022

Additional Accomplishment: Created a tool for increasing communication and clarification of issues between operator, shop foreman and project investigator.

Operator utilizes an app on her phone to enter basic data each time she deploys.

Data from the app is a shared file with the shop foreman and project investigator. By recording issues on the app, patterns have emerged and data is shared regularly.

Date	Temp	Scharge	SMPR	Warning	Code	Echarge	Distance	EMPR
02/27/23	1	87	59	system refrig. press. OOR	F0141	87	19	59
				Limited/No defrost	F0111			
				Perform. Reduced	F0050			
				Shut down Imminent	F0051			
				Power train safety Shutdown	F0051			

Date: Date driven
Temp: Ambient temp
Scharge: starting charge
SMPR: Starting Miles Per Range

Warning: Warning Code
Code: Error Code
Echarge: Ending charge
Distance: Distance Driven
EMPR: Ending Miles Per Range

Collaboration and Coordination Among Project Team

Project Sponsor	Prime Recipient / Project Manager	Special Recognition
US DOE	Solid Waste Services	Peterbilt, Inc.

Deployment Partners

ACEP Alaska Center for Energy and Power

UAF University of Alaska Fairbanks

Analyze and share performance of the EVSE and trucks

ALASKA ENERGY AUTHORITY

$25,000 contribution toward battery and technical support

ecamion

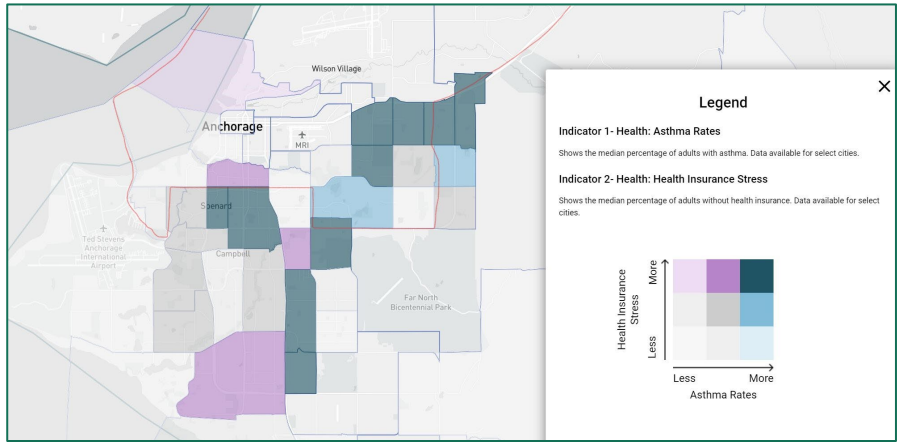
Technology and mechanical design support

Any proposed future work is subject to change based on funding levels

Contribution to Energy Equity and Environmental Justice

SWS's service territory includes areas with the highest asthma rates and health insurance stress, including much of Mountain View along the highway to the Landfill. Electric garbage trucks will reduce pollution along this corridor. A successful pilot could support the broader adoption of electric heavy-duty vehicles. In addition, within the service area is high density living, electric garbage trucks will be significantly quieter, contributing to the wellbeing of residents. The DOE grant allows SWS to complete this pilot project without a cost increase to the ratepayers.

This project will last for years beyond the period of performance. If the heavy-duty trucks and battery operate well, it is likely that more will be integrated into the SWS fleet.



Greenlink Equity Map showing health indices and SWS service territory

2022 Remainder:

- Acquired and integrated the eCamion battery and two charging stations at the new Central Transfer Station Facility set to open late summer 2023
- Monitored and maintained trucks and equipment, paying particular attention to winter operation

2023:

- Acquire and integrate the two 520e garbage trucks and monitor performance using established processes
- Performance assessment of EVs and EVSE with a focus on cold climate operation
- Offer project data and demos to local and statewide fleet managers
- Compare fuel use of EVs to diesel vehicles; calculate savings and carbon reduction
- Develop and share performance assessment summary

Any proposed future work is subject to change based on funding levels

Summary

Barriers

- Cold climate performance of medium and heavy-duty electric vehicles
- Lack of maintenance training
- Battery integration to shave peak demand charges
- The 520e has had multiple manufacturing delays due to supply chain issues and border and factory closures. SWS expects to integrate the vehicles well before the end of 2023
- The 220e box truck has had inconsistent use due to heavy snow events, accumulation, and mechanical issues

Relevance

- Heavy-duty electric trucks are gaining recognition globally but can be challenging in a cold climate. With a start-and-stop duty cycle, garbage trucks are particularly well suited to take advantage of the unique characteristics of an electric motor. As the northern-most major city in the US, Anchorage is an ideal location to demonstrate their applicability. One incident of a rapid reduction in battery occurred on a -10^{o}F day. This has not occurred again.
- Spiking Fuel Costs: Diesel cost $2.85/gallon in 2020 and is currently $4.16 (discounted rate), creating an additional estimated $3,500 fuel savings per year.
- Estimated Maintenance Savings: All work is currently under warranty, so does not yet apply to savings.

Accomplishments

- Created new reporting system increasing communications between the operator, shop foreman and Project Investigator.
- Continued collection of performance and charging data for data analysis and evaluation
- EVSE installed

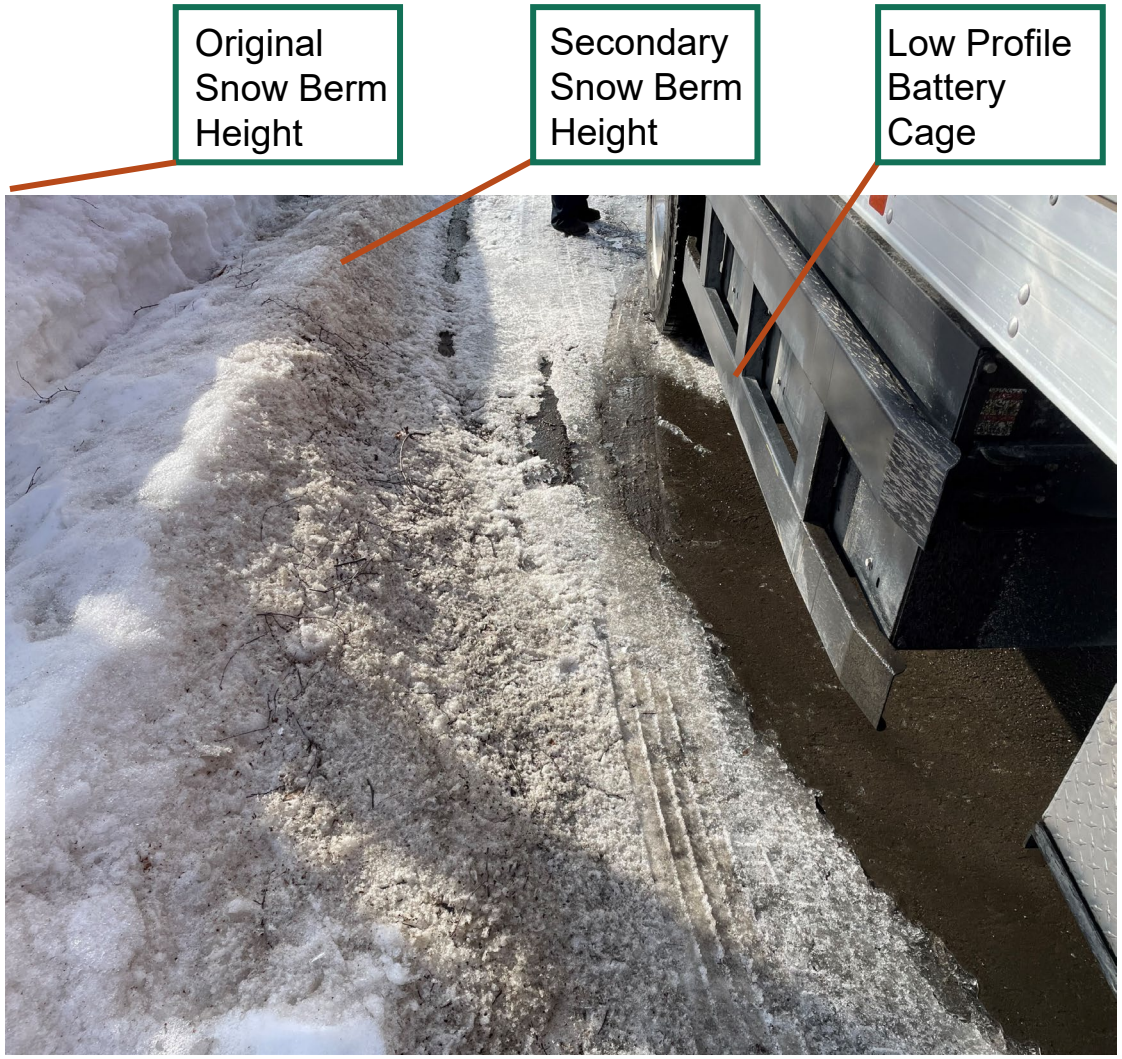
Any proposed future work is subject to change based on funding levels

Technical Backup Slides

EV Fleet Details

	520e Automated Side Loader	220e Box Truck
Manufacturer	Peterbilt, Inc., Meritor, Inc., LaBrie, Inc.	Peterbilt, Inc., Dana, Inc.
Gross Vehicle Weight Rating	67,500 pounds	26,000 pounds
Class	8	6
Battery Type	Liquid-cooled CATL LFP	Liquid-cooled CATL LFP
Battery Size	Up to 424 kWh	141 kWh
Approximate Range	90 miles	100 miles
Daily Maximum Range	50 miles	40 miles
DCFC charging capability	150kW	150kW

Technical Notes



Snow/Cold Climate Operator Points of Interest:

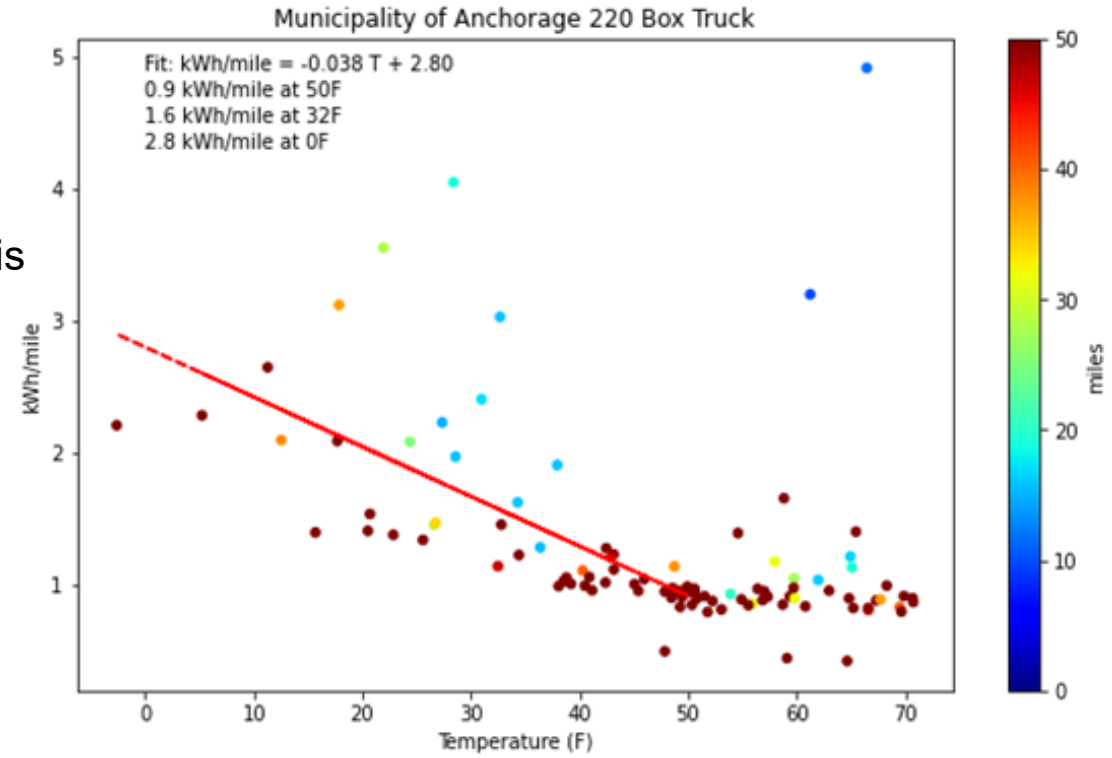
- Regenerative breaking feature disabled during winter to prevent skidding and lack of operator control while breaking.
- Safety sensors appear to detect snow berms and unplowed street; after heavy snow falls as an object in close proximity. During this situation the truck attempts to slow down and come to a stop, while the driver continues to attempt to move forward. This conflict caused the truck to jump in place.
- Heating system is best utilized by adjusting the blower to recycled internal air flow.
- Acceleration pedal has a lag time coming out of a complete stop, also while using regenerative breaking the vehicle will come to a stop, nearly immediately after lifting foot off acceleration pedal. There is no gradual coasting to come to a complete stop as with a fossil fueled vehicle.
- During colder weather the defrost function displays error warnings.

220e Box Truck Analysis

Using the best fit of the data, the box truck shows an energy use (kWh) per mile increasing with decreasing temperature, as expected. However with the addition of warmer weather data, it is clear that above about 50°F the energy use is essentially constant with temperature. Investigating the trends with miles driven, there is more variability and decrease in range, in the energy use at lower trip mileages, likely due to the increased impact of behaviors such as pre-heating the cabin or using battery power for uses other than locomotion.

Modeling using this data shows that this truck, if driven 5200 miles per year, would use approx. 7,500 kWh. At $0.11/kWh, this would cost $825 to charge, and emissions from electricity generation would be approximately 3,750 kg CO2eq. These numbers are, again, much lower than the previously calculated values due to having more data and therefore a more constrained curve fit now.

An equivalent fuel truck with year-round average fuel efficiency of 7 mpg (this may be generous) and fuel prices of $5.14/gallon would cost **$3,818** to fuel, and would emit approx. **7,570 kg CO2eq**



Plot of the energy use per mile of the 220e vs ambient temperature, with a linear fit (Red). Temperature data for Merrill Field, Anchorage from www.NOAA.gov. Charging data used to find energy use downloaded from Chargepoint MOA account. Trip data used to find miles traveled from Dana (Blue), and from MOA hand readings (Orange). The blue point above 10kWh/mile is likely an anomaly due to the assumption that each recharge was to a fully charged state. Date range from 6/18/2021-12/31/22.