

# **Medium-duty Electric Truck (eTruck): Pilot Electrified Fleets in Urban and Regional Applications**

**Principal Investigator: Prof. Junmin Wang**

**Organization: University of Texas at Austin (UT Austin)**

**Presentation Date: June 13, 2023**

**Project ID: TI143**

**Walker Department of Mechanical Engineering  
University of Texas at Austin**

**This presentation does not contain any proprietary, confidential, or otherwise restricted information**



# Overview

## ■ Timeline

- Start: Oct. 1, 2020
- End: Dec. 31, 2024
- Percent Complete: 30%

## ■ Budget

- Total Project Funding: \$2,000,153
  - DOE share: \$1,000,000
  - Cost share: \$1,000,153
- Budget Period 1: \$888,564
  - Expended: \$685,713
- Budget Period 2: \$668,765
  - Expended: \$145,172
- Budget Period 3: \$576,317
  - Expended: \$N/A

## ■ Barriers and Targets

- Limited experience with Medium-Duty (MD) electric trucks (eTrucks) and electric vehicle supply equipment (EVSE) among MD trucking fleets
- Lack technical database for the operation and charging of eTrucks
- Lack of public awareness and exposure to eTruck technology in Texas and Tennessee
- Demonstrate eTruck technology for urban and regional fleet applications and conduct data analysis

## ■ Partners

- University of Texas at Austin (UT Austin)
- Tennessee Technological University (TTU)
- Oak Ridge National Laboratory (ORNL)
- National Renewable Energy Laboratory (NREL)
- Lightning Systems
- SEA Electric
- XOS
- Smart Charge America (SCA)
- Seven States Power Corporation
- Lone Star Clean Fuels Alliance (LSCFA)
- East Tennessee Clean Fuels Coalition (ETCF)
- Middle-West Tennessee Clean Fuels Coalition (MWTCF)
- Texas Trucking Association (TXTA)
- Tennessee Trucking Association (TTA)

# Project Objectives

## Objectives

- Develop an MD eTruck demonstration testbed of different MD eTrucks for various urban and regional applications in a diverse range of trucking fleets in Texas and Tennessee

## Impact

- Assist trucking fleets to gain MD eTruck knowledge and experience for identifying suitable applications and making informed decisions in eTruck adoption
- Collect real-world eTruck fleet operation and usage data dedicated specifically to the challenges and needs associated with electrification of MD trucking fleets
- Increase public awareness on the current state of MD eTruck technology through outreach and education

## VTO Technology Integration Goals

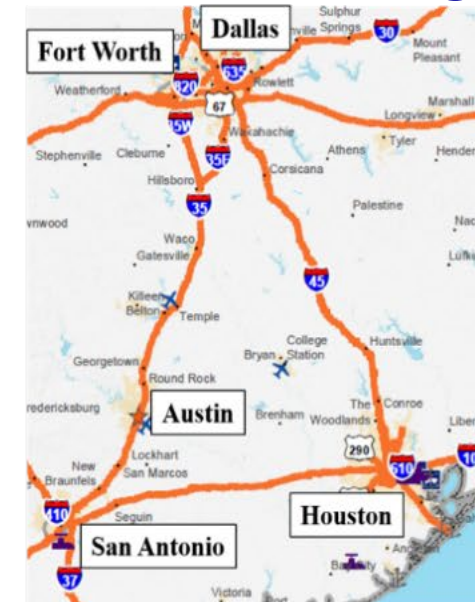
- Improving fuel diversity: Reduce the use of fossil fuels and natural gas in MD trucking fleets
- Increasing local resiliency:
  - Installation of electric vehicle (EV) charging infrastructure to increased infrastructure reliability
  - Electricity-powered trucks reduce dependence on fossil fuels and promote the use of clean and sustainable energy for transportation
  - Provide an alternative transportation option that is cleaner and more sustainable compared to conventional MD trucks
- Reducing greenhouse gas emission: Increase alternative fuel use

# Project Sites

- A class-4 eTruck and a class-5 eTruck for fleet demonstration in the Texas Triangle that covers Austin, Dallas-Fort Worth, Houston, and San Antonio
  - Both eTrucks will be loaned in Austin and San Antonio in Budget Periods 1~2
  - Each eTruck will either be loaned in Houston or Dallas in Budget Periods 2~3
- A class-4 eTruck will be assigned to serve several major logistical hubs across Tennessee
- Any proposed future work is subject to change based on funding levels



(a) Project Sites in Tennessee



(b) Project Sites in Texas

# Project Approach

## Budget Period 1

Oct. 2020 - Dec. 2022

### Project Initiation & Deployment

- Acquisition and instrumentation of MD eTrucks
- Recruitment of trucking fleets as the project participants
- Demonstration of the eTrucks to different fleets in Texas and Tennessee
- Data collection and analysis
- Information exchange, outreach and education activities to promote eTruck awareness and readiness

## Budget Period 2

Jan. 2023 - Dec. 2023

### Project Continuation

- Continuation of eTruck demonstration in Texas and Tennessee
- Data collection and analysis
- eTruck modeling and simulation
- Information exchange, outreach and education activities

## Budget Period 3

Jan. 2024 - Dec. 2024

### Deployment Expansion

- Continuation of eTruck demonstration in Texas and Tennessee
- Data collection and analysis
- Information exchange, outreach and education activities

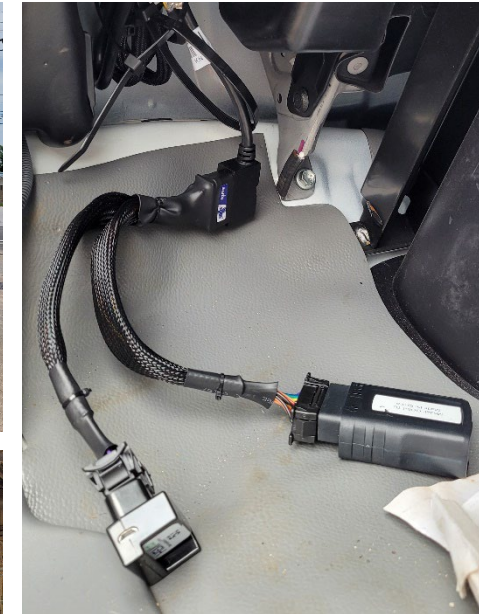
Any proposed future work is subject to change based on funding levels

# Project Approach - Milestones

	Milestone	Type	Description	Progress
Budget Period 1	eTruck platform construction	Technical	Complete the acquisition, instrumentation, and functionality checks of three eTrucks	100% Complete
	Fleet recruitment plan	Technical	Finish the fleet recruitment plans for the eTruck demonstration	100% Complete
	Outreach plan	Technical	Create outreach plans in Texas and Tennessee	100% Complete
	Data analysis methods developed	Technical	Develop preliminary data analysis methods and model structure	Mostly finished
	MD eTruck Demonstration	Go/No Go	Demonstration in 6 fleets are achieved	80% Complete
Budget Period 2	Data analysis updated based on actual data	Technical	Improve data analysis method and refine the total-cost-of-ownership model with actual data collected	Started
	Outreach programs refined	Technical	Refine outreach activities through feedback at UT Austin and TTU	Started
	Demonstration Progress Achieved	Go/No Go	Demonstration in approximately 20 fleets are finished; outreach plans are developed and initiated; preliminary data analysis methods and model structure are developed.	Started
Budget Period 3	Demonstration in approximately 40 fleets	Technical	Complete approximately 40 fleets in Texas and Tennessee	Not started
	Data analysis complete	Technical	Finalize the data analysis and the total cost of ownership model, provide data-based eTruck adoption	Not started
	Outreach programs finished	Technical	Fully disseminate project findings	Not started

# Accomplishments & Progress – Demonstration Preparation

- **Acquisition of three eTrucks for demonstration**
    - Texas: Class-4 LEM (2020), Class-5 SEA (2021)
    - Tennessee: Class-4 XOS (2023)
  - **Data acquisition system (DAQ) setup**
    - List of signals available coordinated among the eTrucks
    - Used manufacturer provided telematics or third-party data logger with custom server setup
  - **Fleet recruitment**
    - Various fleet recruitment materials and public website prepared to aid the process
    - Received applications are evaluated based on the fleet type, size, weekly mileage, accessibility to charging station, etc.
- ※ The preparations for eTruck demonstration in both Texas and Tennessee are completed



US DEPARTMENT OF ENERGY PROJECT  
**SEEKING TRUCKING FLEETS FOR ELECTRIC TRUCK STUDY**  
CLASS 4 & CLASS 5 ELECTRIC TRUCKS AVAILABLE  
THREE MONTH USAGE FOR FREE!

**PARTICIPATING FLEET MUST:**  
- be located in Austin, Dallas, Houston, or San Antonio  
- have experience with medium-duty trucks  
\* Level-2 charging station will be provided for the duration of the study

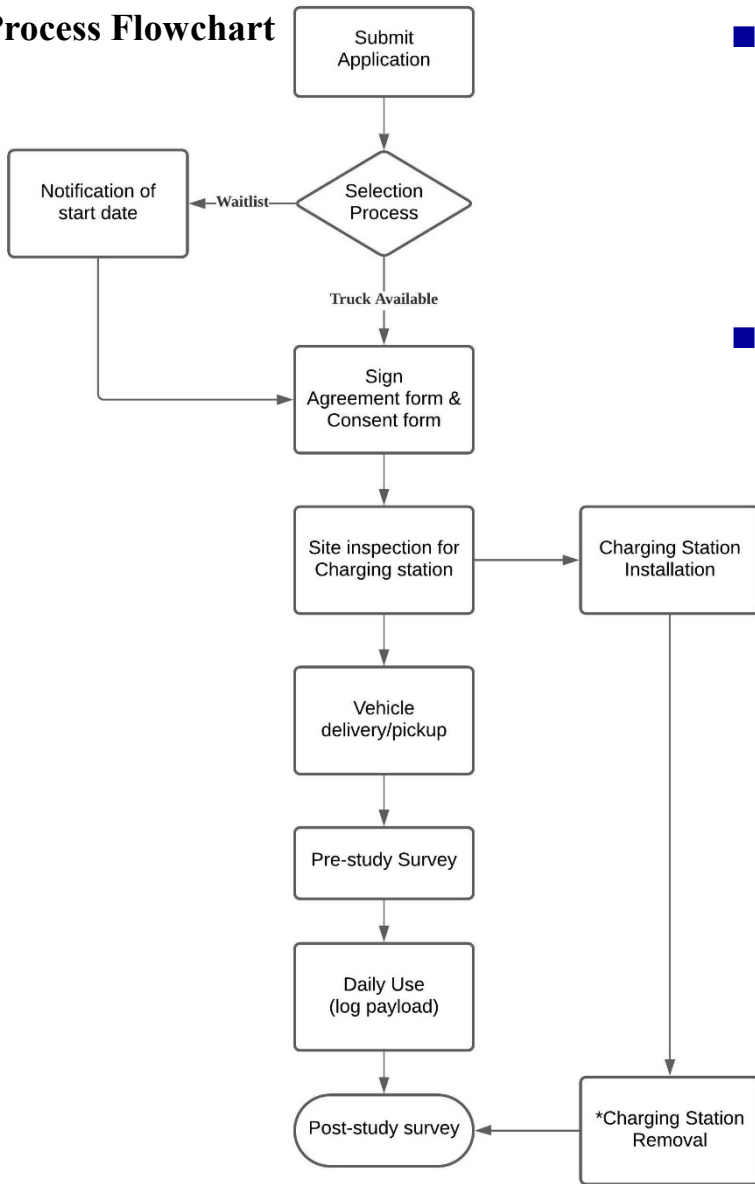
If interested, please fill out the **start form**.  
[https://utexas.qualtrics.com/jfe/form/SV\\_07g7bbFT9ozJF3w](https://utexas.qualtrics.com/jfe/form/SV_07g7bbFT9ozJF3w)

**Contact Information**  
Coordinator: Jin Ahn      PI: Prof. Junmin Wang  
Email: [hjahn@utexas.edu](mailto:hjahn@utexas.edu)      [JWang@austin.utexas.edu](mailto:JWang@austin.utexas.edu)  
Phone: 512-574-2564      512-232-2392  
Address: 10500 Exploration Way, Austin, TX 78758

Start Form  
  
SCAN ME

# Accomplishments & Progress – Demonstration

Process Flowchart



## ■ Demonstration process

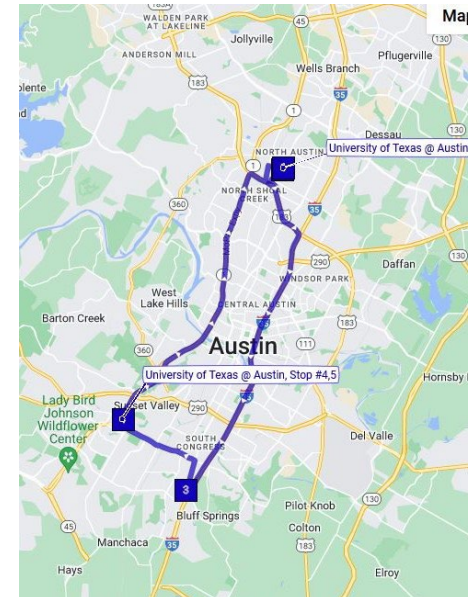
1. eTruck loan agreement with insurance verification
2. Charging station site inspection / installation
3. Vehicle use by participants
4. Post-study survey / interview

## ■ Demonstration Statistic

Criteria	Description
Number of Fleets	3 fleets completed, 2 in progress
Loan period	Texas: 3 months*, Tennessee: 1 month
Loan preparation time	Approximately 1 month
Fleet Type	University: 1, Government: 1, Commercial: 3
Average miles/day	Class-4: 15.1, Class-5: 35.7
Charging Pattern	Varies in frequency. Level-1 and level-2 observed.

\* Extension granted for downtime/repair

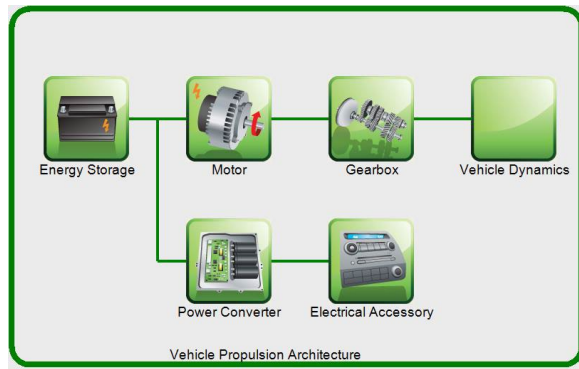
※ The demonstrations of eTrucks are currently undergoing and operational data from various trucking fleets have been collected.



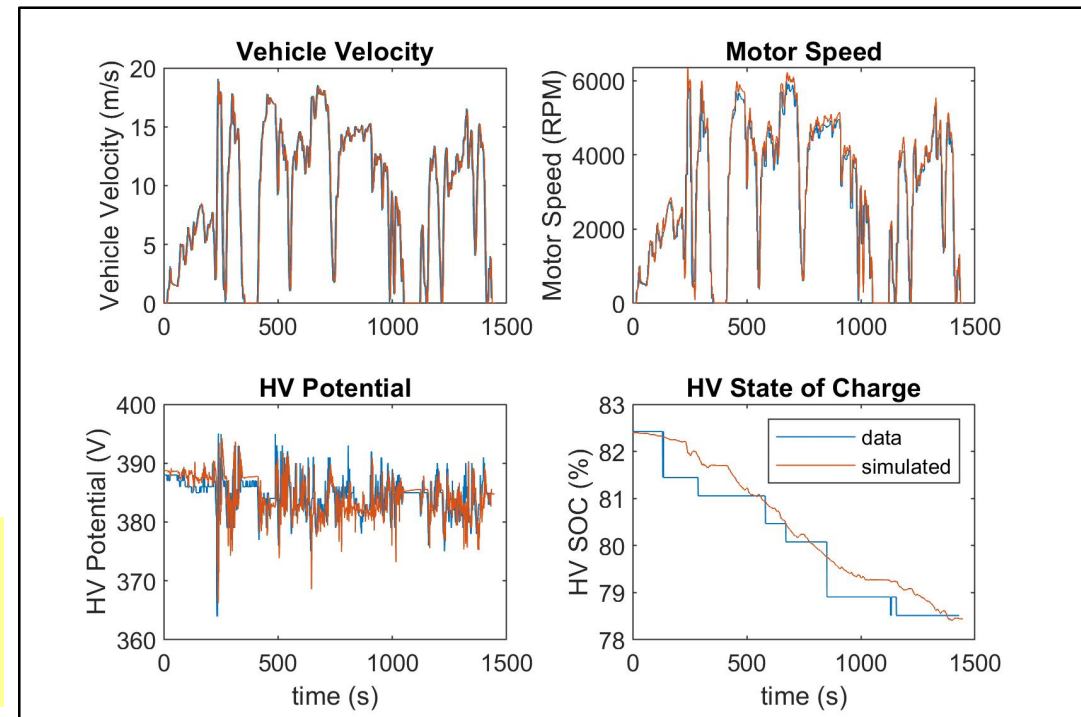


# Accomplishments & Progress – Data

- **To process operational data collected from the eTrucks:**
  - Differentiate and label the operations by driving / idling / charging
  - (SEA truck) Consolidate data from multiple telematics devices of different sampling frequencies
  - Include the payload log entries manually recorded by the truck drivers
- **Vehicle model created in Autonomie/AMBER (Argonne National Labs)**
  - Base parameters obtained from the manufacturers or extracted from the part specification documents
  - Certain proprietary parameters were estimated using the collected driving data



✳ The processed data, with the vehicle model, will allow for more accurate simulation and in-depth analysis of of the eTruck usage



# Accomplishments & Progress – Survey

## ■ Pre/Post-study survey

- Survey to evaluate the awareness of eTrucks before and after the study
- Determine whether the study has helped to gain knowledge and experience
- Different versions for fleet managers / drivers
  - Driver survey focus: operation (driving range, charging, payload, drivability)
  - Manager survey focus: management (cost, plan for adoption, charger installation)
  - Common: maintenance, general perception, environmental friendliness
- Fleet specific questions
  - e.g., low driving noise as a possible safety concern for university fleets
- 5-point Likert Scale for statistical analysis

## ■ Fleet manager interviews

- Gain additional insight into eTruck usage that is not available from numerical data
- Allow for better understanding of unique behaviors of each fleet
  - e.g., frequently visited stops, use of level-1 charging

✳ **User experience surveys and manager interview will allow for more accurate analysis and better understanding of the eTruck operational data**

12:29

How familiar are you with MD electric trucks before and after the study?

(1=Not at all familiar, 2=Slightly familiar, 3=Moderate, 4=Very familiar, 5=Extremely familiar)

	1	2	3	4	5
Before Study	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
After Study	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

What is your level of **satisfaction** with the electric truck?

(1=Extremely dissatisfied, 2=Somewhat dissatisfied, 3=Neither, 4=Somewhat Satisfied, 5=Extremely Satisfied)

	1	2	3	4	5
Overall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Driving Range	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Charging	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Driving comfort	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Manager Survey

# Accomplishments & Progress – Outreach & Education

## ■ Outreach & Education in Tennessee

- Prof. Pingen Chen (The PI at TTU) was invited to speak about the challenges and opportunities of electrification of MD trucks at the inaugural Tennessee Smart Mobility Expo in the Smart Academia session, Aug. 4-6, 2022, Nashville TN.
  - Project team exchanged project information with leading industry companies
- TTU and ETCF partnered with Thompson Truck Centers to present XOS electric step van and Nikola heavy-duty electric truck at:
  - The 2022 Drive Electric TN (DET) Momentum Summit, Nov. 7, Knoxville, TN.
  - The 2022 Tennessee Sustainable Transportation Forum & Expo, Nov. 8-9, Knoxville, TN.
  - Project poster was presented to the attendees and class-6 electric step van was made available for ride and drive during event.
  - Project team exchanged project information and discussed partnership with electric truck manufacturers.
- Additional outreach events planned in Cookeville, Tennessee (April 15, 2023) and in Nashville, Tennessee (April 22, 2023). Electric step van will be presented for the showcase.



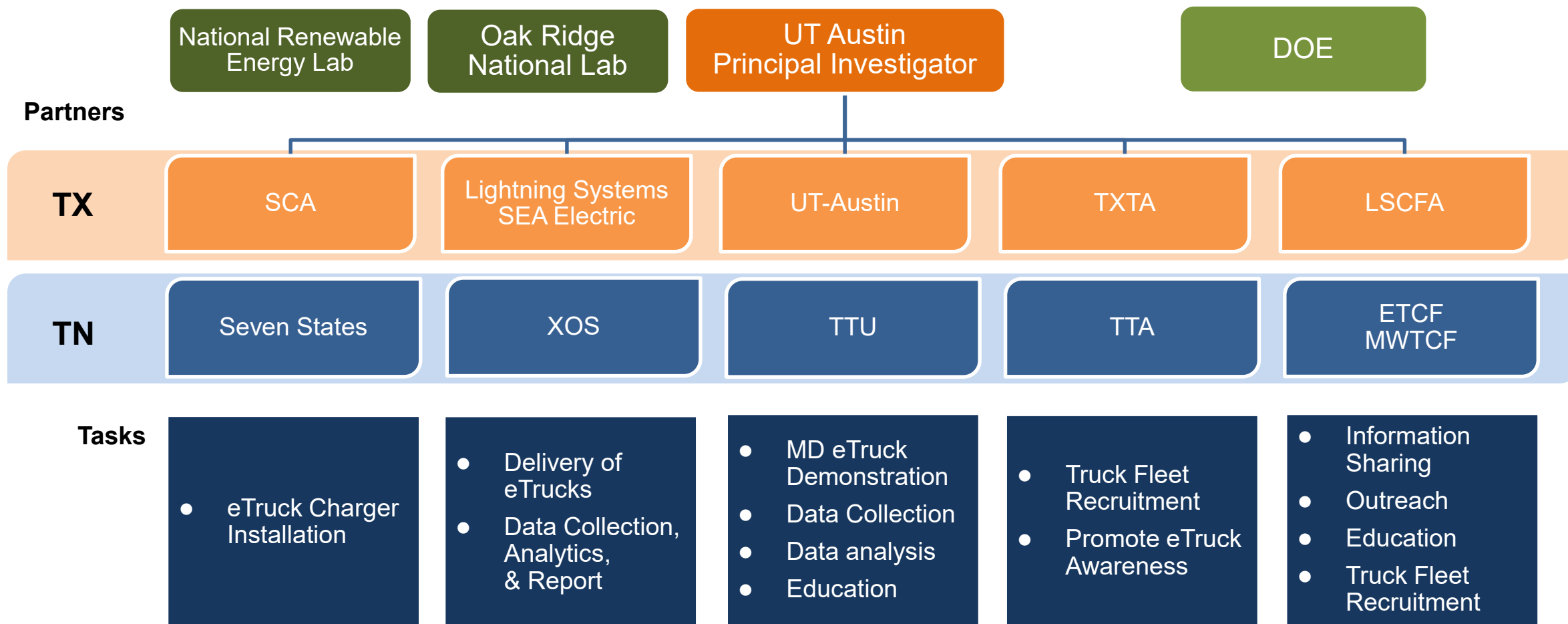
# Accomplishments & Progress – Outreach & Education

## ■ Outreach & Education in Texas

- Project team attended SAE (Society of Automotive Engineers) meeting in Austin, TX (Oct. 28, 2021)
  - Demonstrated the LEM eTruck to the SAE members & public attendees
- Project team attended Electric & Hydrogen Vehicle Workshop and Ride & Drive event hosted by LSCFA (Mar. 7, 2023)
  - SCA presented a session on fleet charging strategies and the current state of charging infrastructures in TX



# Collaboration and Coordination among Project Team



# Contribution to Energy Equity and Environmental Justice

The project may contribute to energy equity and environmental justice by benefitting the underserved and overburdened communities in the following ways.

## ■ Underserved Communities

- Provide eTruck operational experience to financially-constrained or small trucking fleets
- Education and outreach of eTruck technology and governmental policies to the public
- Real-world data collected can be utilized to support policies aimed at improving access technology for underserved communities or assist manufacturers in developing solutions that better meet the needs of these communities

## ■ Charging Infrastructure

- Charging stations installed at fleet sites, away from residential areas, reducing burden on the public facilities (avoid negative impact)
- The potential site inspections and consultation services provided during the installation process will benefit communities with no or limited charging facilities in their future installation plans

## ■ Environmental Impact

- Reduce noise pollution on communities near trucking fleets
- Reduce local air pollution

# Summary

<b>Goal</b>	MD eTruck demonstration to a diverse range of trucking fleets in Texas and Tennessee, and data analysis of MD eTrucks in various applications
<b>Project Outcomes</b>	<ul style="list-style-type: none"><li>• Assist potential owners gain eTruck experience for identifying suitable applications and make informed decisions in eTruck adoption</li><li>• Collect real-world eTruck fleet operation and usage data dedicated specifically to the challenges and needs associated with MD trucking fleets</li><li>• Increase public awareness on the current state of MD eTruck technology</li></ul>
<b>Approach</b>	<ul style="list-style-type: none"><li>• Acquisition, instrumentation and demonstration of three MD eTrucks to various trucking fleets in Texas and Tennessee</li><li>• Analysis of collected data</li><li>• Information exchange, outreach and education activities to promote eTruck awareness and readiness</li></ul>
<b>Major Accomplishments</b>	<ul style="list-style-type: none"><li>• Completed the acquisition, instrumentation, and functionality checks of the three eTrucks</li><li>• The fleet recruitment plan and necessary documentation prepared for the demonstration</li><li>• Successful completion of eTruck demonstration to several fleets in Texas</li><li>• Attended and presented at multiple outreach events in Texas and Tennessee</li></ul>
<b>Next steps</b>	<ul style="list-style-type: none"><li>• Continued demonstration and data collection, in current and other sites in Texas and Tennessee</li><li>• Any proposed future work is subject to change based on funding levels</li></ul>

# Technical Backup Slides



# Data Collection

- All three eTrucks have telematic devices to collect driving data in real-time
- All data is collected wirelessly
- List of signals for the eTrucks were matched as closely as possible
  - \*For SEA truck, a second datalogger (HEM) is installed for signals missing in the default Geotab device
- LEM truck
  - Sampling at 1Hz
  - CSV file format
  - Software that automatically pulls data once a week
- SEA truck
  - Geotab
    - Curve Logging - data measurement every time a change is seen for that datapoint
  - HEM OBD2 logger
    - Records custom signals from CANBUS (Using Diagnostic port)
    - Sampling at 1Hz

# List of Signals Collected

## ■ GPS Data

- GPS connection status
- Latitude
- Longitude
- Altitude
- Odometer

## ■ Dynamics

- Velocity
- Key state
- Gear state (Parking)
- Accelerator Pedal
- Brake Pedal
- Wheel Speed

## ■ Charging

- EVSE state
- EVSE potential
- EVSE current

## ■ Battery

- HV Battery SOC
- HV Battery Power
- HV Battery Potential
- HV Battery Current
- LV Battery Potential

## ■ Temperature

- Cabin Temperature
- Ambient Temperature

## ■ Motor

- Motor Speed
- Motor Torque

- eTruck payload will be logged manually by fleet drivers