Building Successful Partnerships between Rural Transit Systems Deploying Zero-Emission Vehicles and their Electric Utilities

August 4, 2020

CTE Whitepapers for N-CATT

Today's Webinar:

- *Building Successful Partnerships between Rural Transit Systems Deploying Zero-Emission Vehicles and their Electric Utilities*

August 18th Webinar:

- *Hydrogen as a Transportation Fuel in Rural Communities*

Overview

- About CTE
- Zero-Emission Vehicles (ZEVs) Overview
- Working with your Electric Utility during Fleet Electrification
- Framework for Building Partnerships
- Case Studies

About CTE

WHO WE ARE

501(c)(3) nonprofit engineering and planning firm

OUR MISSION

Improve the health of our climate and communities by bringing people together to develop and commercialize clean, efficient, and sustainable transportation technologies

PORTFOLIO

$571 million

- *Research, demonstration, deployment*
- *90 Active Projects totaling over $316 million*

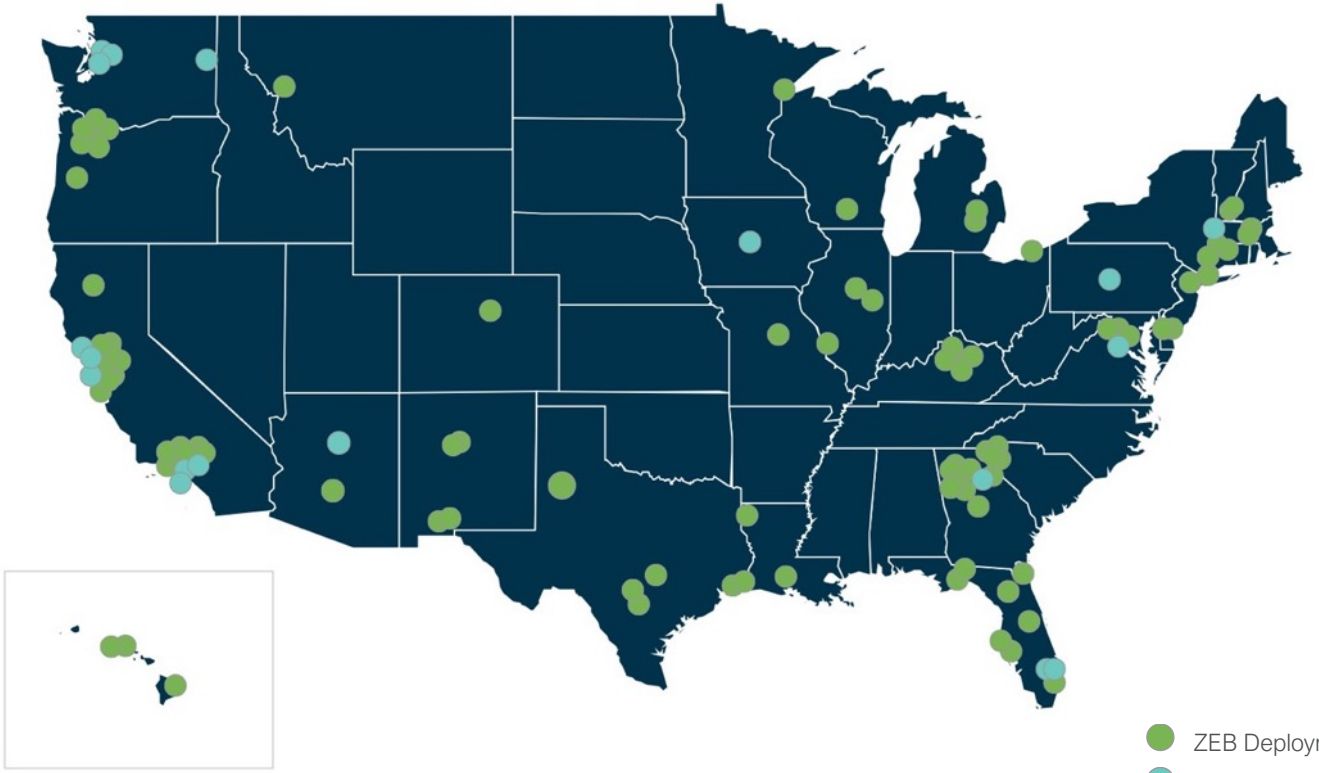
OUR FOCUS

Zero-Emission Transportation Technologies

NATIONAL PRESENCE

Atlanta, Berkeley, Los Angeles, St. Paul

CTE Zero Emission Bus Projects



Our Four Service Areas

Prototype Development & Demonstration

We support technology providers through technology research, development, and demonstration.

Smart Deployment

We support early adopters by providing the best technical solutions for initial deployments.

Fleet Transition

We help fleet operators implement strategic plans for full electrification.

Education & Outreach

We help organizations of all shapes and sizes stay ahead of the technology curve.

Overview

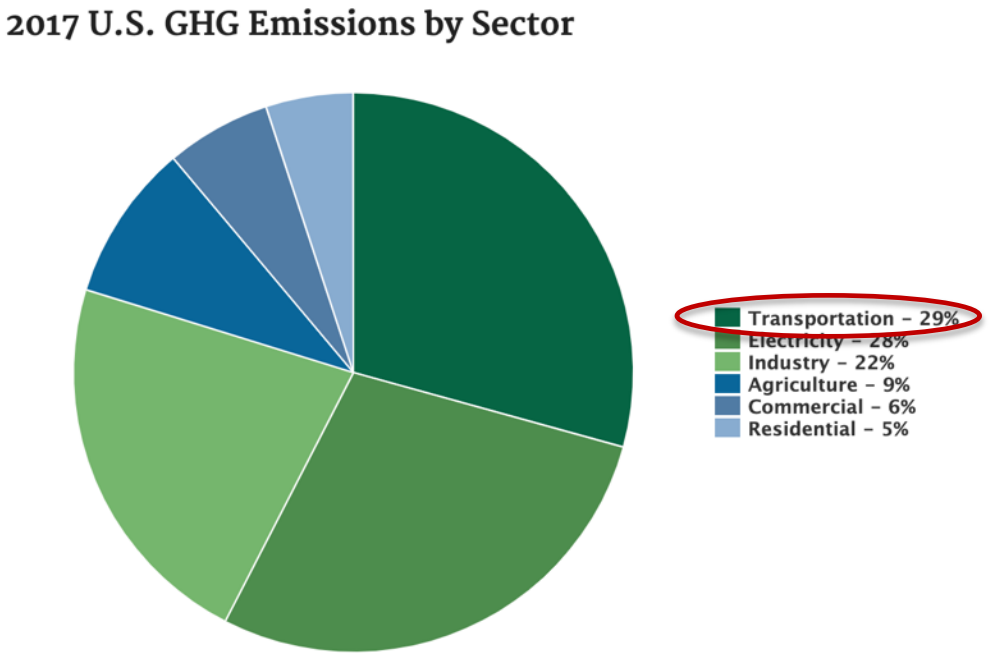
- **Overview of White Paper**
  - *Alison Smyth, Engineering Consultant, CTE*
  - *Maggie Maddrey, Associate, CTE*
  - *Amy Posner, Engineering Consultant, CTE*

- **Zero-emission Transit Vehicles in Vermont**
  - *Van Chestnut, Executive Director, Advance Transit*
  - *Jennifer Wallace-Brodeur, Director, Transportation Efficiency, VEIC*

- **Working With Electric Co-ops to Extend Electric Transit**
  - *Brian Sloboda, Director, Consumer Solutions, National Rural Electric Cooperative Association*

Benefits of ZEVs

- ✓ Lower emissions
- ✓ More efficient
- ✓ Cleaner and quieter
- ✓ Lower operating costs



Source: U.S. Environmental Protection Agency

Rural Agency Vehicle Types

Table 20. Vehicles by Mode, 2015

	Fixed-Route	Demand-Response	Van Pool	Commuter Bus	Demand-Response Taxi	Ferryboat	Bus Rapid Transit	Aerial Tramway
Bus	2,010	1,406	9	319	0	0	36	0
Cutaway	2,498	9,181	0	358	0	0	0	0
Van	242	3,046	217	0	101	0	0	0
Minivan	0	3,709	99	0	133	0	0	0
Automobile	13	264	0	0	149	0	0	0
School Bus	8	60	0	0	0	0	0	0
Over-the-road bus	15	0	0	58	0	0	0	0
Sports Utility Vehicle	0	220	7	0	2	0	0	0
Aerial Tramway	0	0	0	0	0	0	0	59
Articulated Bus	1	0	0	2	0	0	0	0
Ferryboat	0	0	0	0	0	14	0	0
Other	30	5	12	17	6	2	17	0
Total	*4,817*	*17,891*	*344*	*754*	*391*	*16*	*53*	*59*

Source: Rural National Transit Database, 2015

= 3,780
= 12,037
= 3,606
= 3,941

Zero-Emission Vehicle Overview: Transit Buses

Long Range Battery Electric Bus (BEB)

Fast-Charge BEB

Fast-Charge BEB


Fuel Cell Electric Bus (FCEB)

	Battery Capacity	Fuel Cell Power	Reliable Range in Transit Service	Estimated Capital Costs for Base Vehicle	Typical Fueling Approach
Long Range BEBs	250 – 660 kWh	N/A	< 150 miles on a single charge	$740K	DC fast charging (50-150 kW)
Fast-Charge BEBs	50-250 kWh	N/A	Indefinite range possible with periodic on-route charging	$750K-1M	Overhead conductive chargers (175-600 kW) Wireless inductive chargers (50-250 kW)
FCEBs	50-150 kWh	85-120 kW	200-320 miles	$1 M	Hydrogen fueling via delivery or on-site production

Zero-Emission Vehicle Overview: Cutaways

Image Source: Motiv

	OEM-Advertised Max Battery Capacity	OEM-Advertised Range	Typical Fueling Approach
Lightning's E-450 Cutaway	129 kWh	80 - 120 miles	Level II depot charging (~20 kW) or DC fast charging (~50 kW)
Motiv's Champion Shuttle Bus	106 kWh	85 miles	Level II depot charging (~20 kW) or DC fast charging (~50 kW)
Phoenix Motors' Zeus 400 Shuttle Bus	150 kWh	160 miles	Level II depot charging (~20 kW) or DC fast charging (~50 kW)

Zero-Emission Vehicle Overview: Passenger Vans

Image Source: Lightning Systems

	OEM-Advertised Max Battery Capacity	OEM-Advertised Range	Typical Fueling Approach
GreenPower's EV Star	118 kWh	150 miles	Level II depot charging (~20 kW) or DC fast charging (~50 kW)
Lightning's Ford Transit LEV60/120	43– 86 kWh	60 - 120 miles	Level II depot charging (~20 kW) or DC fast charging (~50 kW)

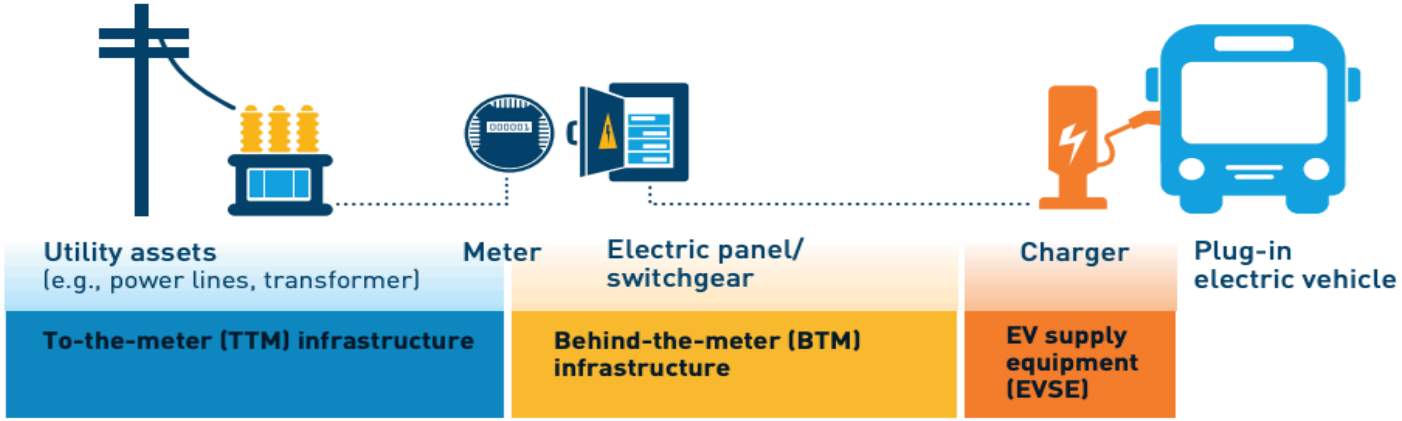
Other Rural Fleets

- School Districts
- Local, County, and State Governments
- Trucking Companies

Source: Blue Bird Corporation

Why Work with your Electric Utility?

- Understand each other's constraints
- Lower operational costs
- Make smart investments



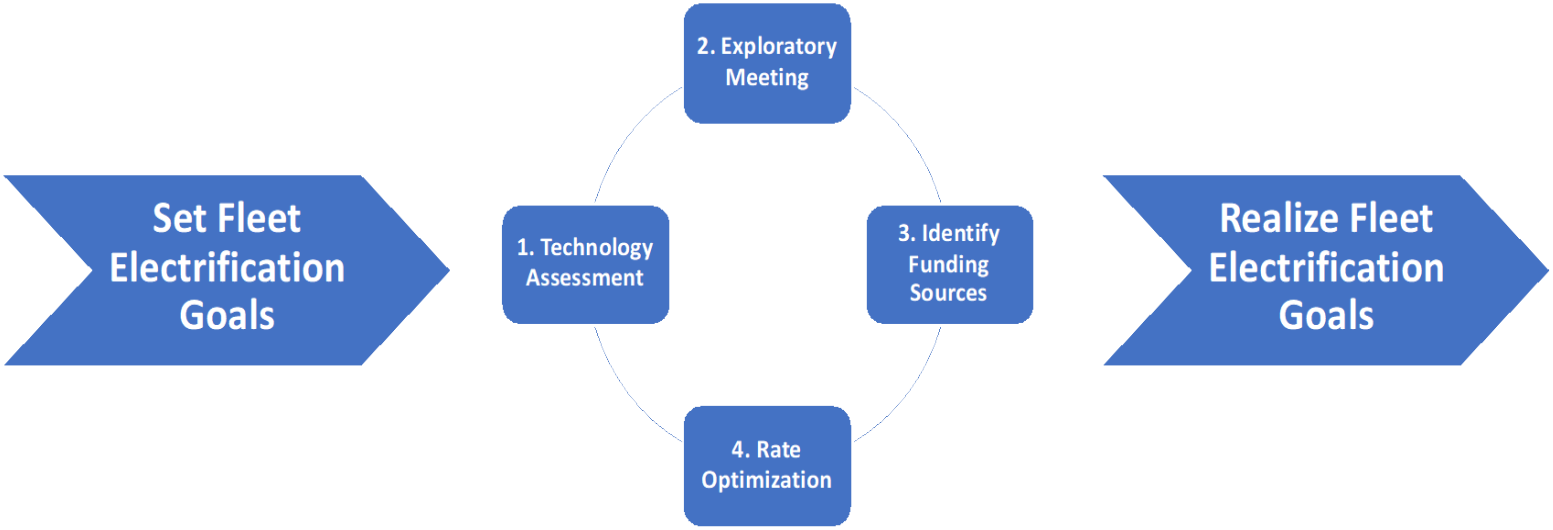
Source: Pacific Gas and Electric Company

Three types of Electric Utilities

	PUBLIC POWER UTILITIES	RURAL ELECTRIC COOPERATIVES	INVESTOR-OWNED UTILITIES
BUSINESS MODEL	✓ Not for profit, community-owned	✓ Not for profit, member-owned	✓ For profit, share-holder owned
GOVERNED BY	✓ Elected/appointed boards– mayors, city council members, citizens	✓ Member-elected boards	✓ Private boards

Source: American Public Power Association

Framework for Building Partnerships Between Transit Agencies and Electric Utilities



Transit agency and electric utility coordination during incremental deployment projects

Set Fleet Electrification Goals

- Set up a project team
- Short- and long-term goals for ZEV deployments
- Design incremental deployment projects

Estimated Timeframe	Number and type of vehicles	Fueling type (i.e., Level II, DC fast charging, on-route charging, hydrogen)	Estimated electrical capacity needed	Possible funding sources	Criteria for evaluating success

Energy Capacity Calculator

- Provided in the white paper to estimate required energy capacity by number and type of vehicles
- Excel format calculates estimated capacity and allows for customization

Estimated Electrical Capacity Calculator

Instructions: Fill in the boxes shaded in yellow with data for the vehicle types that you are considering electrifying. Review all plans for electrification with your electric utility during the planning process. Estimated charger power is provided, but you are welcome to change the values based on information you have on specific technology that you are considering.

CALCULATOR

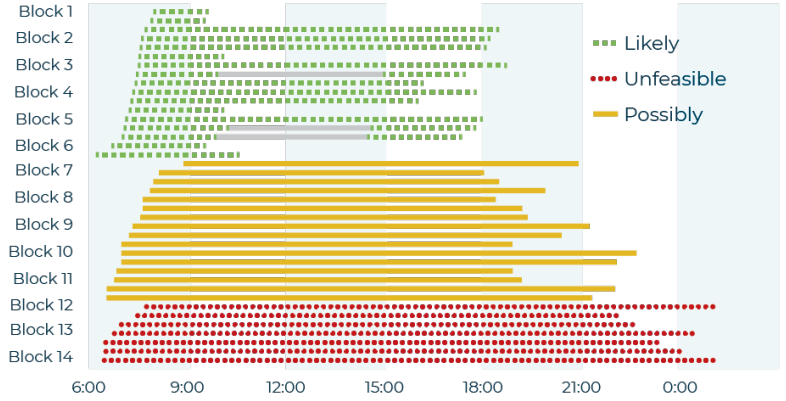
Type of Equipment	Number of chargers needed for planned fleet	Estimated Charging Power (kW)	Guidance	Timeline for Vehicle Deployment
Battery Electric Buses (> 30')				
Depot-charged		50	Level III DC chargers for BEBs typically range from 50 kW to 150 kW	
Overhead Conductive Charged		300	Overhead fast chargers can range from 175 kW to 600 kW	
Inductive Charged		250	Inductive chargers can range from 50 kW to 250 kW	
Battery Electric Cutaway		20	Assumes a Level II charger. DC fast charging is available for most battery electric cutaways. If considering DC fast charging, use a similar estimate as a depot-charged transit bus.	
Battery Electric School Bus		20	Assumes a Level II charger. DC fast charging is available for most battery electric cutaways. If considering DC fast charging, use a similar estimate as a depot-charged transit bus.	
Battery Electric Van, Minivan, Automobile, Sports Utility Vehicle		20	Assumes a Level II charger	
Ferry Boat		1000	Available data suggests that electric ferry boats would utilize a charger that can completely recharge the battery in 30 minutes to one hour (e.g., a 1 MWh ferry will probably charge at a rate of 500 kW to 1 MW)[1]	
Estimated grid capacity per charger	110%		Assume an additional 10% of grid capacity is needed to support the rated power of each charger	
Power Factor	1		Assume a power factor of 1 unless your electric utility or charger OEM instructs you otherwise	

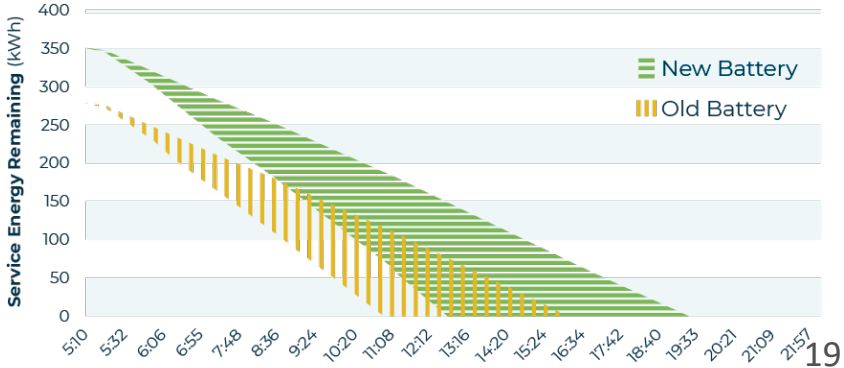
RESULTS

Estimated Electrical Capacity Needed to Electrify the specified fleet[2,3]	**0**	**kW**

Technology Assessment

- ZEV industry is rapidly maturing
- Re-evaluate ZEV options when beginning a deployment
- Route and charge modeling can inform performance and costs





Exploratory Meeting with Electric Utility

- Points to discuss:
  - Short- and long-term electrification goals
  - Available funding opportunities
  - Planned charging strategy
  - Carbon reduction goals
  - Requirements for resilience

- Ongoing coordination throughout all ZEV deployments

Identify Funding Sources

- Example Federal and State funding sources for ZEVs:
  - FTA's Low or No Emission Vehicle Program (Low-No)
  - FTA's Bus and Bus Facilities Program
  - FTA's Funding for Tribal Entities
  - Volkswagen Environmental Mitigation Trust

- Coordinate with your State DOT, State RTAP Manager, FTA Tribal Liaison, and your electric utility when applying for funding

Rate Optimization - Understanding your Utility Bill

Fixed Cost

- Monthly fee for having a meter
- Typically <1% of monthly bill

Energy Cost

- How much fuel you buy
- Can vary by time of day/season
- $/kWh

Demand Cost

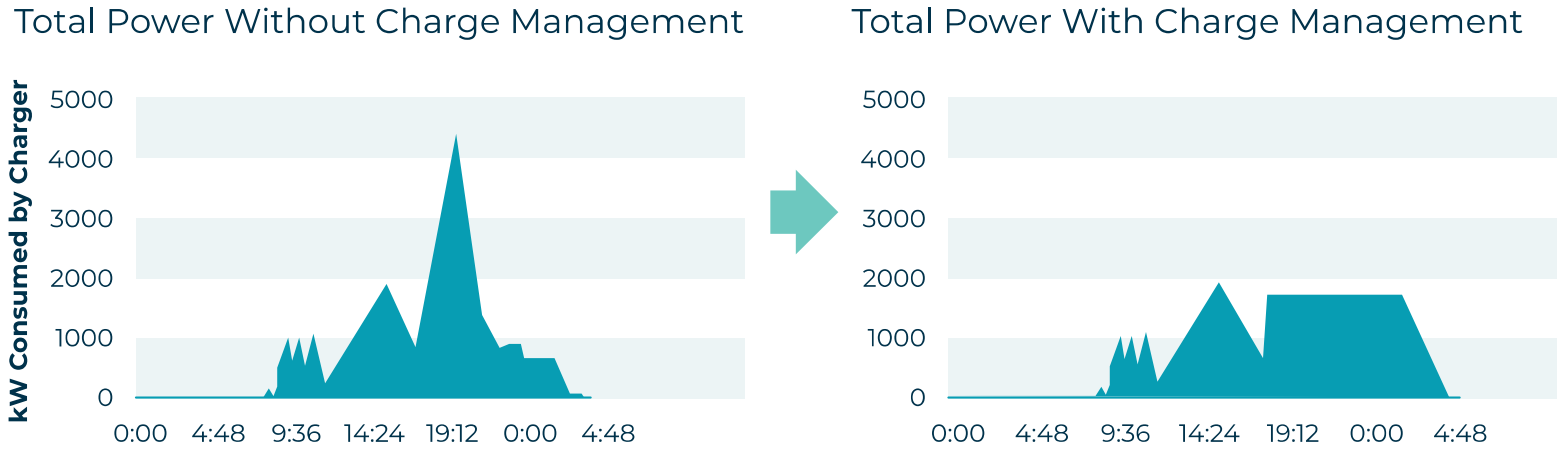
- How fast you fuel
- Impacted by charge power, # of chargers operating at once
- Can vary by time of day/season
- $/kW

Taxes and Fees

- Typically 5-30% of monthly bill

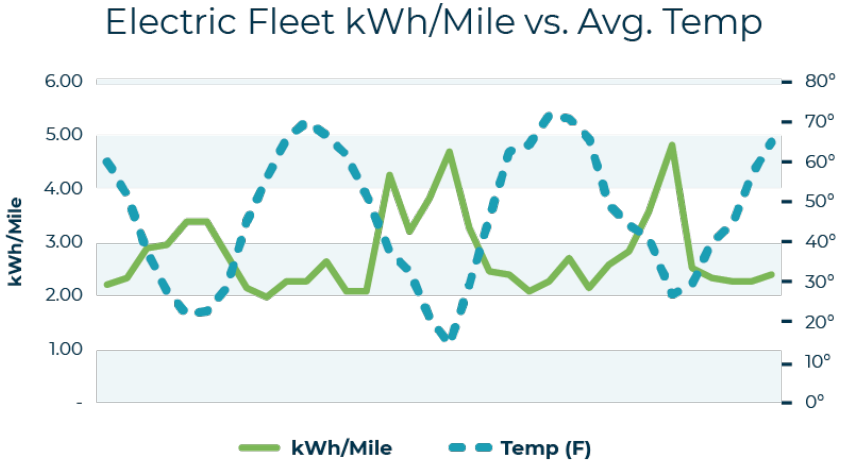
Rate Optimization

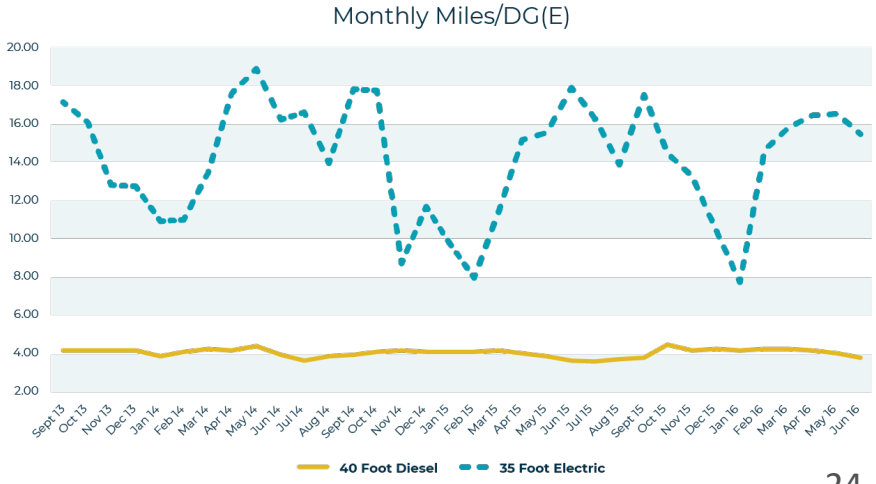
- Charging your ZEVs may have a big impact on your utility bill
- Work with your utility to figure out a charging strategy



Realize Fleet Electrification Goals

- Incorporate lessons learned into future deployments
- Performance monitoring and reporting





WELCOME TO ZERO

2020 INTERNATIONAL

ZERO EMISSION BUS CONFERENCE

ONLINE • SEPTEMBER 15TH - 17TH

REGISTER FOR FREE AT ZEBconference.com

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Electric Bus Technology & Vermont Pilots

Van Chesnut, Advance Transit & Jennifer Wallace-Brodeur, VEIC

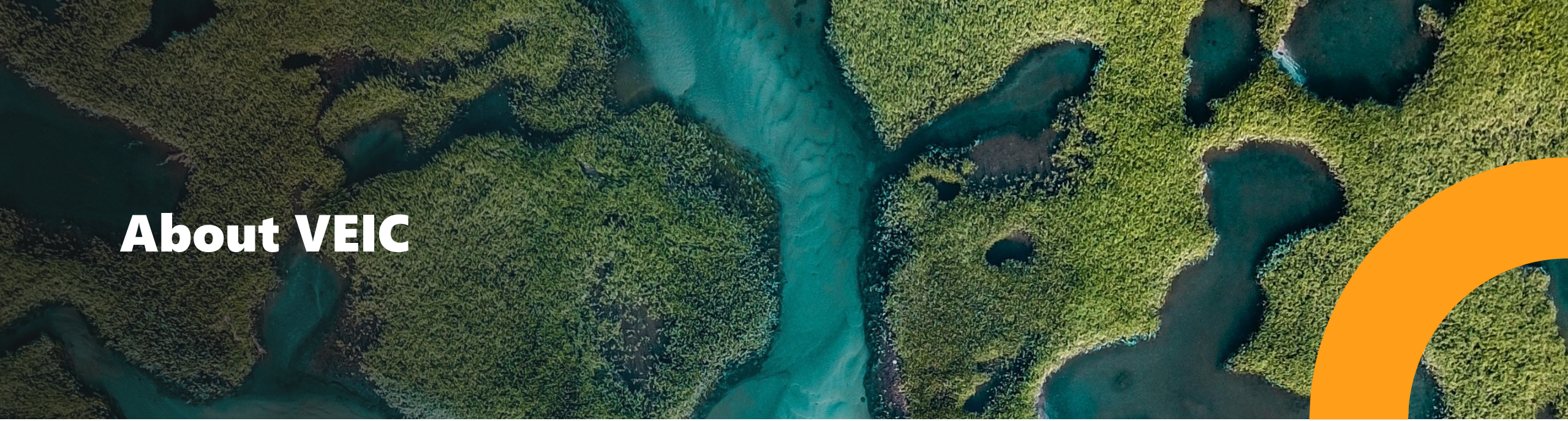
About Advance Transit

Nonprofit, bi-state, rural public transit system that provides free transit service to six communities in New Hampshire and Vermont.

Operates several fixed-routes, park-and-ride shuttles, and complementary ADA paratransit

Combined ridership in FY 2018 of 877,720

Annual budget is $4.5M



About VEIC

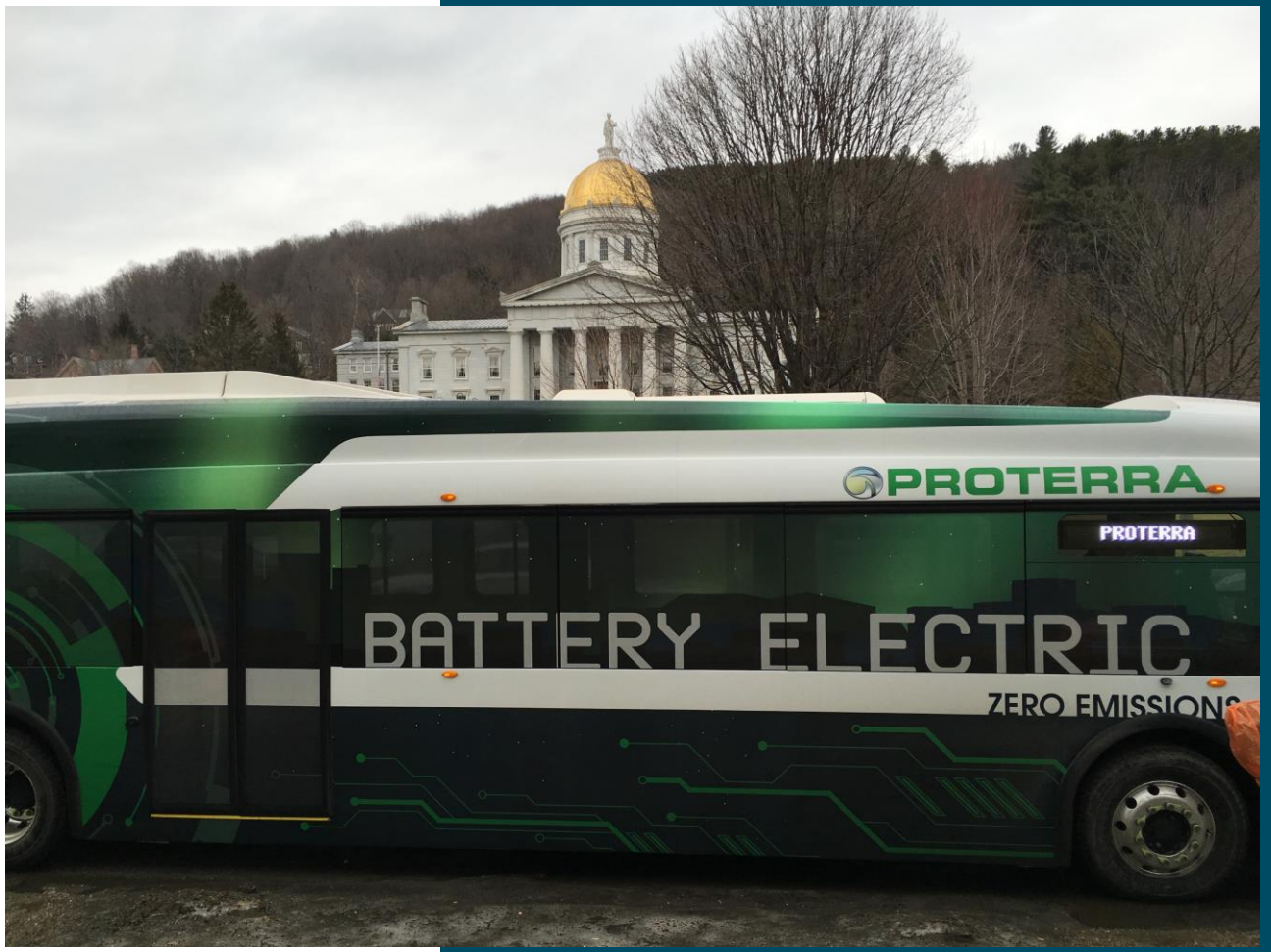
We are on a mission to generate the energy solutions the world needs.

The health of our planet is in our hands. That's why VEIC works with organizations across the energy landscape to create immediate and lasting change. Since 1986, we've served as an objective partner for our clients as they navigate complex energy challenges. With expertise in energy efficiency, building and transportation electrification, and new approaches for a clean and flexible grid, we bring solutions to the market that meet your goals.

Every challenge is different, but our commitment is the same: make an impact

VT Policy Framework for Electrification

- VT Long Range Transportation Plan
- VT Public Transit Policy Plan
- Comprehensive Energy Plan
- Renewable Energy Standard
- VW Settlement – Beneficiary Mitigation Plan



2017 Electric Bus Pilot

- Test performance in cold weather; evaluate benefits in real world operation
- Buses operated by Advance Transit, Green Mountain Transit, University of Vermont
- Project partners: VTrans, Burlington Electric Dept., Green Mtn Power, VEIC

Pilot Findings

- The all-electric bus was more efficient, less expensive to operate, and produced significantly lower emissions than a new diesel bus
- Performance and savings varied by operating environment
- Drivers generally liked the electric bus experience
- Results paved way for BEB deployments

VT Transit Electrification Projects

Green Mountain Transit

Advance Transit

Marble Valley Regional Transit District

Rural Community Transportation

Green Mountain Express

TOTAL = 14 electric buses (full size and cutaways)

Advance Transit Project

- 4 electric buses: 2 35’ Gilligs; 2 cutaways
- Facility upgrades to support chargers
- Funded by Low and No Emissions Vehicle Program
- Cost share from Green Mountain Power

Vermont Utility Partnerships

Get in touch

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Working With Electric Co-ops to Extend Electric Transit

Brian Sloboda
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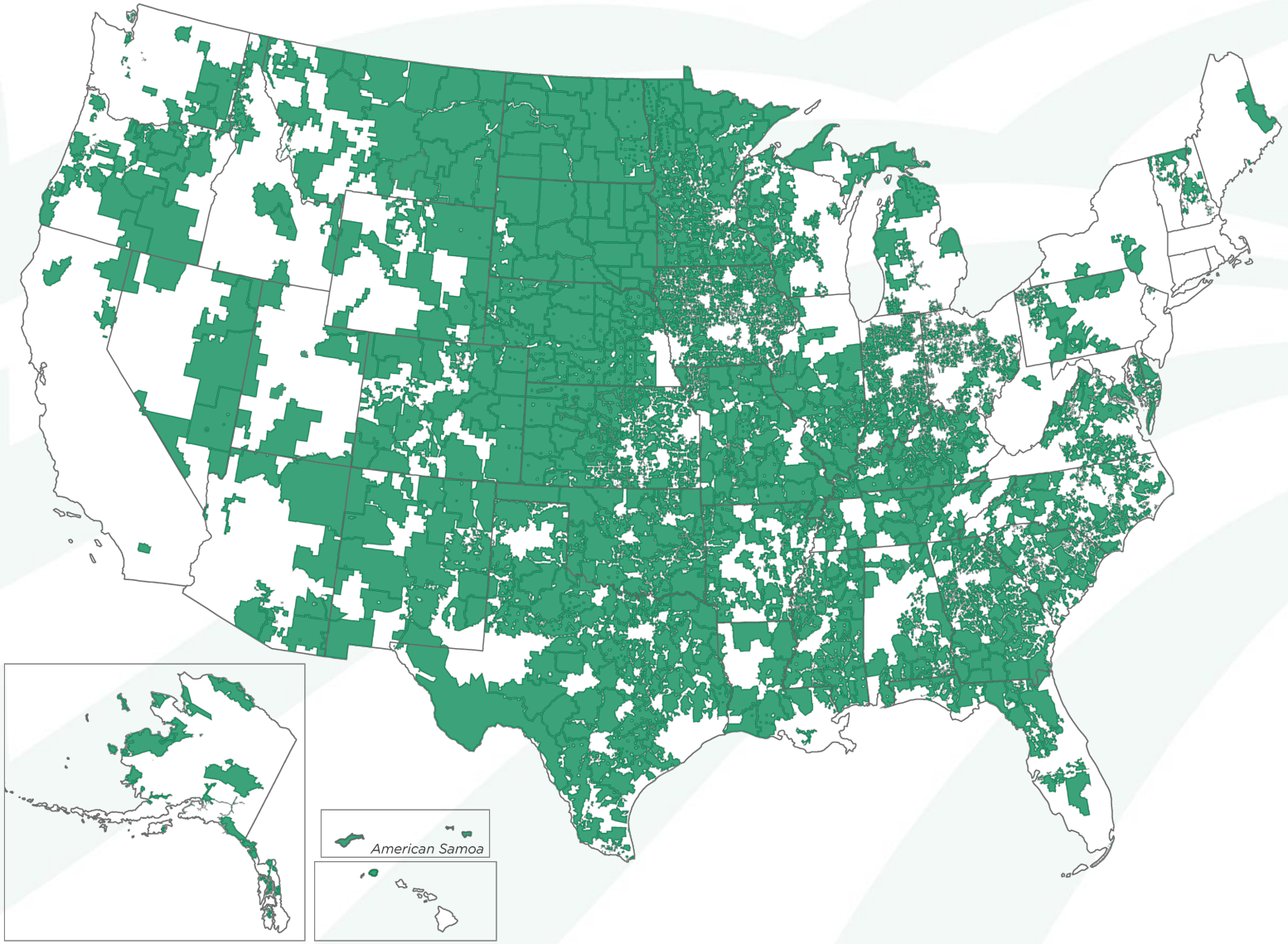
NRECA
America's Electric Cooperatives

America’s Electric Cooperatives

- Consumer owned
- Not for profit
- 48 states
- 833 distribution utilities
- Serve 88% of US counties



NRECA
America’s Electric Cooperatives

REV: February 2020

Key Considerations

- Engage with Your Electric Provider Early and Often
- Minimize fuel cost
- Electricity Is Delivered in Real Time
- Electric Bill Depends on How You Charge
- Electricity as a Fuel Means Thinking About Fuel Availability in New Ways

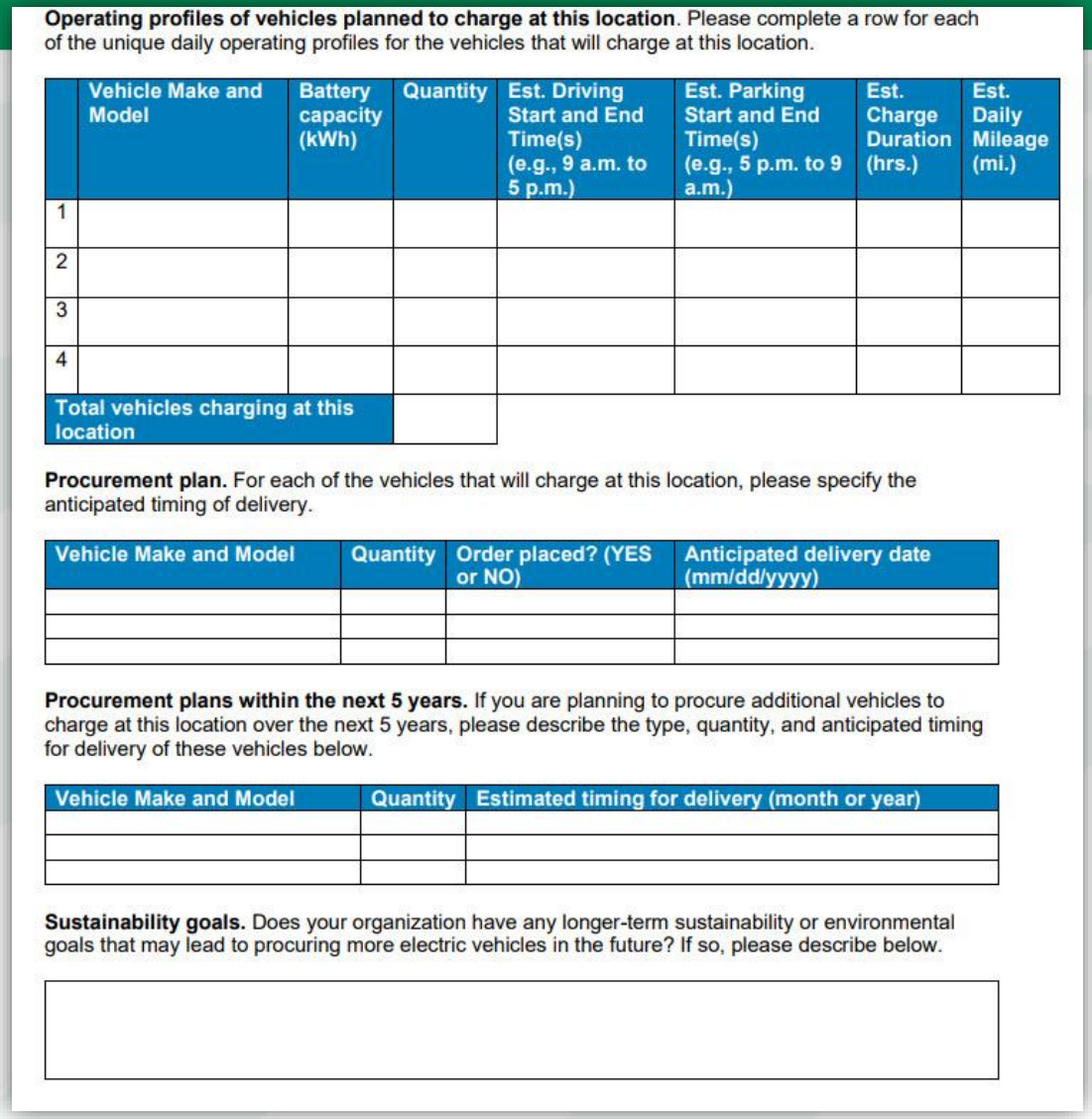
NRECA
America's Electric Cooperatives

Many Issues

- Market Issues
- Battery Issues
- Regulatory Issues
- Power Issues
- Utilities build assets to match current and future load
  - Long-term investments
  - Few envisioned trucks and bus charging

How to Start the Conversation

- Charger size- kW
- Battery size
- Time you **think** you may charge
- Flexibility on when to charge
- Think 5 years out



Operating profiles of vehicles planned to charge at this location. Please complete a row for each of the unique daily operating profiles for the vehicles that will charge at this location.

	Vehicle Make and Model	Battery capacity (kWh)	Quantity	Est. Driving Start and End Time(s) (e.g., 9 a.m. to 5 p.m.)	Est. Parking Start and End Time(s) (e.g., 5 p.m. to 9 a.m.)	Est. Charge Duration (hrs.)	Est. Daily Mileage (mi.)
1							
2							
3							
4							
Total vehicles charging at this location							

Procurement plan. For each of the vehicles that will charge at this location, please specify the anticipated timing of delivery.

Vehicle Make and Model	Quantity	Order placed? (YES or NO)	Anticipated delivery date (mm/dd/yyyy)

Procurement plans within the next 5 years. If you are planning to procure additional vehicles to charge at this location over the next 5 years, please describe the type, quantity, and anticipated timing for delivery of these vehicles below.

Vehicle Make and Model	Quantity	Estimated timing for delivery (month or year)

Sustainability goals. Does your organization have any longer-term sustainability or environmental goals that may lead to procuring more electric vehicles in the future? If so, please describe below.

NRECA
America's Electric Cooperatives

https://www.cooperative.com/topics/distributed-energy-resources/Pages/Preparing-to-Plug-In-Your-Electric-Transit-Bus-Fleet---10-Things-To-Consider.aspx

Summary

- Talk early… before you make decisions
- Cooperation is key
- Flexibility is even better
- Avoid charging during peak utility times… typically late afternoon
- Talk about vehicle to grid uses… long-term

NRECA
America's Electric Cooperatives

Thank you!

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