

PROTERRA CATALYST® PLATFORM INTRODUCTION



Presentation to

California Transit
Association

November 14, 2019



Proterra's Mission

Advancing electric vehicle technology to deliver the world's best-performing heavy-duty vehicles

- Offices and manufacturing in CA and SC
- 500+ employees, with strong transportation expertise
- >100 customers; >800 vehicles sold
- >10,000,000 service miles
- >50,000,000 pounds of CO2 emissions avoided



Strong Transportation Expertise



World-Class Financial Partners



HIGH-QUALITY, ADVANCED MANUFACTURING FOR RAPID EV ADOPTION AT SCALE



Burlingame, California

*Battery Manufacturing
Company HQ*



Los Angeles, California

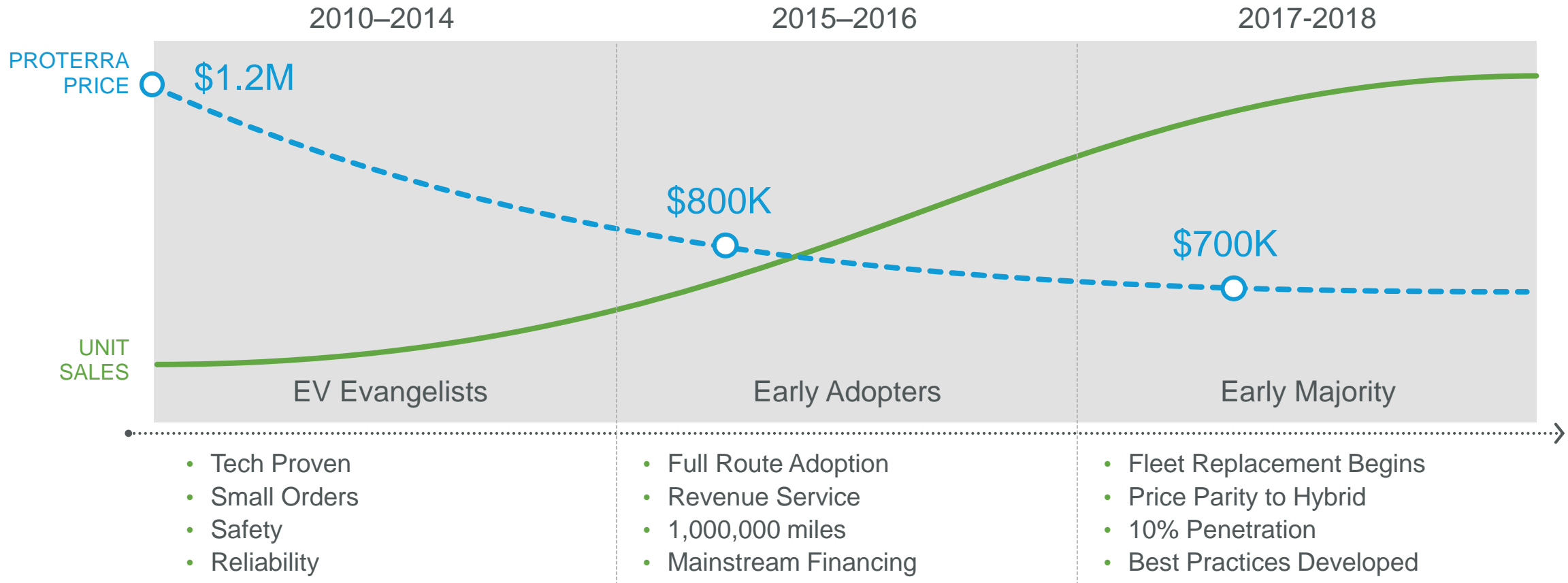
*Bus Manufacturing
West Coast Operation*



Greenville, South Carolina

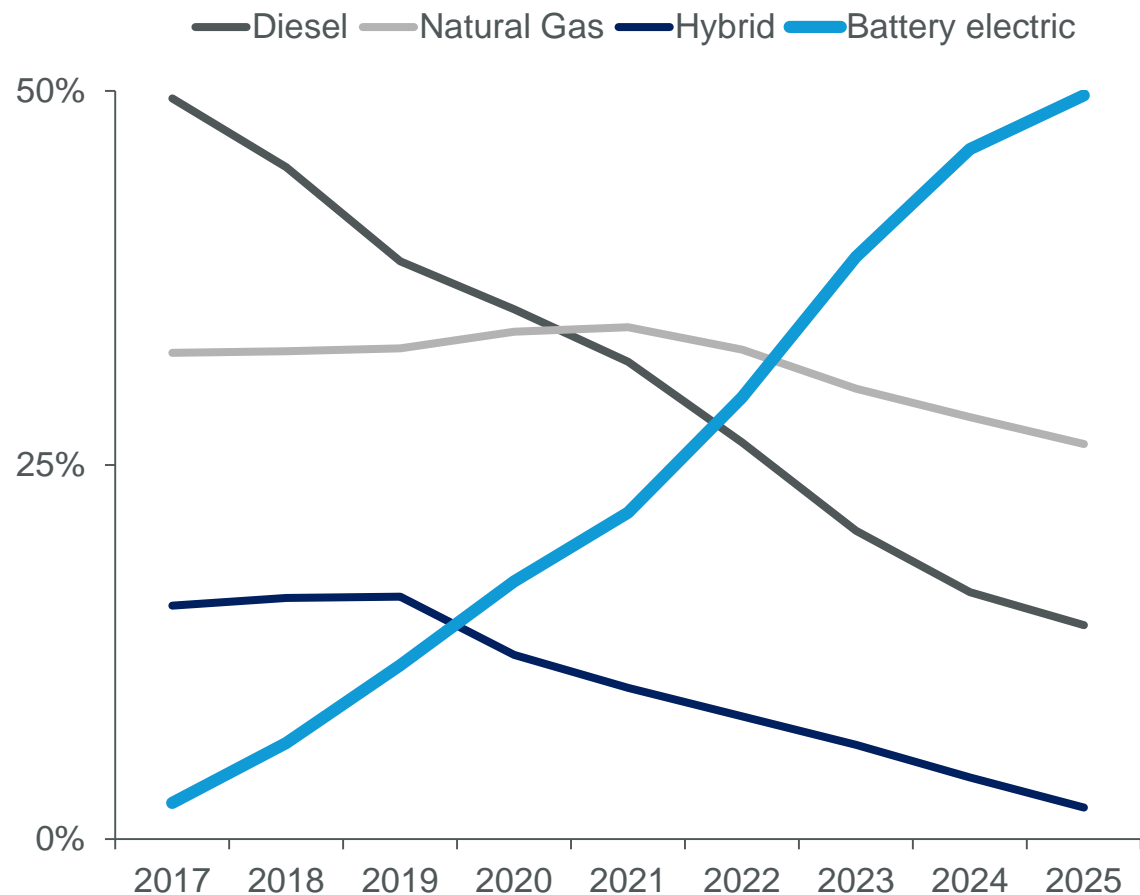
*Bus Manufacturing
East Coast Operation*

THE TRANSIT MARKET IS RAPIDLY SHIFTING TO EV



EV Transit Bus adoption continues to increase

Major cities adopting EV technology for transit buses



Source: Frost & Sullivan Heavy Duty Transit Bus North America Powertrain Adoption Forecast

 New York 100% EV by 2040 4,700 buses	 Chicago Piloting since 2014 2,100 buses	 Washington D.C. 100% EV by 2045 1,900 buses
 Seattle 100% EV by 2034 1,500 buses	 Philadelphia Piloting since 2017 1,500 buses	 Miami 50% EV by 2035 800 buses

California mandates 100% electric transit buses by 2040

New purchase mandates

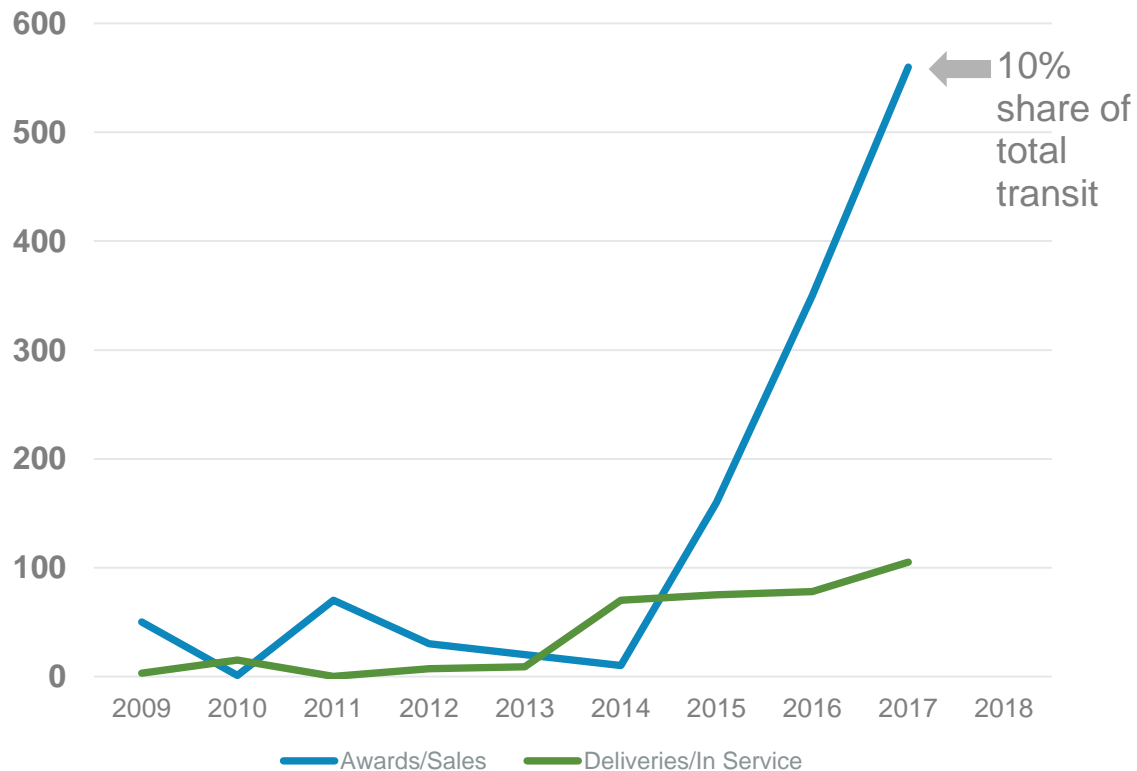
25% → **50%** → **100%**

by 2023 **by 2026** **by 2029**

12,000 buses across California
(17% of nationwide fleet)

Source: National Transit Database; agency websites; 2017 American Public Transportation Association Fact Book

Battery Electric Buses: North American Annual Sales and Deliveries



- Moving toward **widespread industry adoption**
- Major cities making commitments to zero-emission transportation
- **Purchase barriers eliminated** due to:
 - Improved range
 - Charging standardization
 - Sharp decline in battery costs
 - Service-proven performance

Source: CTE Center for Transportation and the Environment 2017

OUR CUSTOMERS

Proterra has the largest ev customer base in north America



PROTERRA



100+
customers

800+
buses sold

42
states/provinces

NORTH AMERICA'S FAVORITE BUS



15+ YEARS OF EXPERIENCE WITH BATTERY-ELECTRIC BUSES ENABLING INFORMED PRODUCT DEVELOPMENT



PROTERRA

VEHICLE



- Proterra Eco-Ride
- Delivered in 2010
- Fast-charge only



- Proterra Catalyst® platform
- Launched in 2014
- Long-range & fast-charge
- Up to 660 kWh capacity

BATTERY



- 3rd party battery suppliers



- Proterra batteries designed and manufactured in-house specifically for heavy-duty transit
- Industry-leading energy efficiency
- Rigorous battery safety testing

DRIVETRAIN



- One drivetrain option



- Proterra DuoPower™ drivetrain
- Fastest Acceleration, Greatest Horsepower, 5X More Efficient Than a Diesel Bus

CHARGING



- Proprietary charging technology, non-universal



- Proterra Charging Systems engineered in-house
- Universally standardized
- Proterra Energy™ fleet solutions to support infrastructure needs

HIGHLY DIFFERENTIATED AND FULLY INTEGRATED HEAVY DUTY TECHNOLOGY PLATFORM



PROTERRA

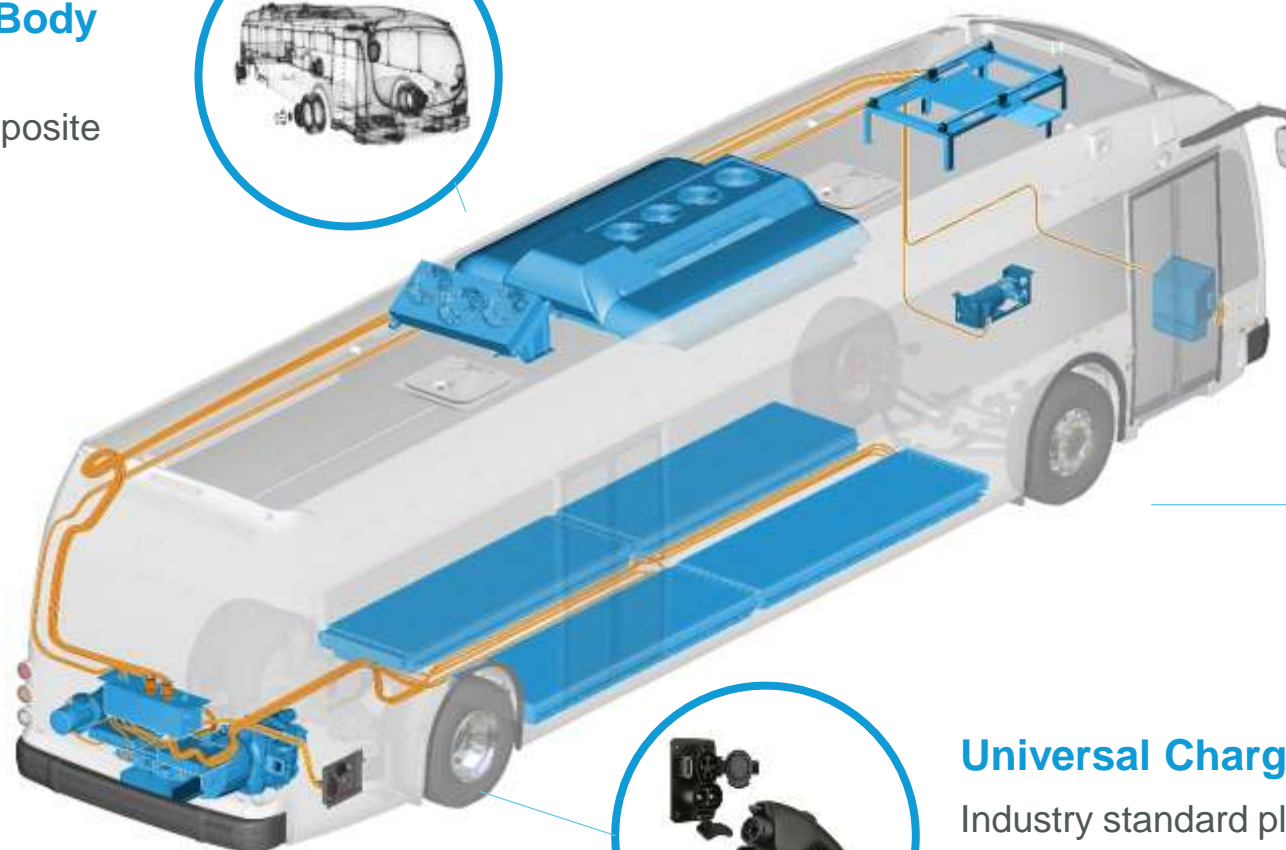
Advanced Composite Body

Lightweight and durable
carbon-fiber-reinforced composite



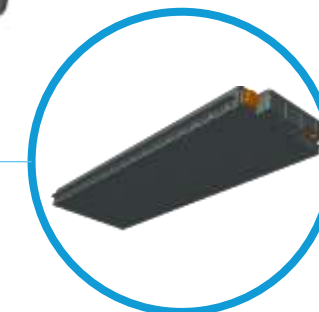
High Efficiency Drivetrain

5x efficiency of diesel
Greatest horsepower
Fastest acceleration



Heavy Duty Battery Pack

High energy density,
ruggedized battery packs
purpose built for commercial
vehicles

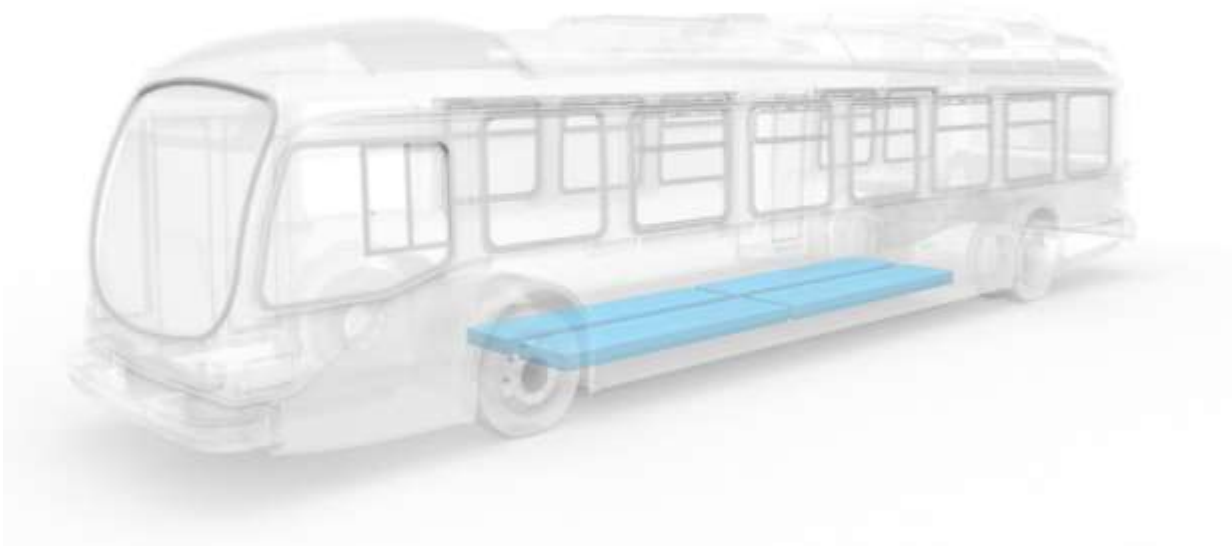


Universal Charging

Industry standard plug-in and
overhead high power Level 3
charging

Proterra buses are purpose-built from the ground up to be electric, enabling the safest placement of batteries

- Underneath and outside of passenger compartment
- Separated by a sealed bulkhead below the floor of the bus
- Avoids placing batteries in the rear of bus, which is a common crash zone
- Battery placement creates a lower center of gravity for greatest vehicle stability



Proterra battery packs have undergone extensive testing to meet the highest safety standards.



Tests performed to account for possible incidents such as:

- Vehicle crash
- Road debris striking the battery pack
- Street manhole cover explosion
- Defective or failed cell within pack
- Overcharge of high voltage system
- Coolant flood internal to battery pack
- Fuel fire external to the vehicle (collision with a combustion engine vehicle)

Proterra battery packs are designed specifically for safe operation in heavy-duty transportation.



- Protective, **ruggedized enclosure** made with ballistic-grade materials that can withstand the toughest conditions
- Pack design ensures service technicians and operators are protected from high voltage components
- Liquid cooling for **active thermal management** to ensure optimal operation in any climate
- More than **70 sensors** throughout each pack delivers continuous monitoring and diagnostics, enabling faster service
- If a single cell within the battery fails, the pack is designed such that the defective cell will be isolated to a small region of the pack and not cause complications throughout the entire pack.
- Rigorously tested and 3rd party validated



~1 MWh shown

- Batteries will retain significant energy storage capability long after their first life in a transit bus
- Stackable design, retaining interface and safety features
- Hardware designed to exist >12 years in outdoor environmental conditions
- Capable of serving multiple storage requirements for renewable energy, grid services, demand management and emergency backup

THE PROTERRA CATALYST MODELS



PROTERRA



CATALYST XR
220
kWh

XR

XR

220 kWh energy on board
92-118 miles operating range*
2.8 hrs charge time**

CATALYST E2
440
kWh

E2

E2

440 kWh energy on board
150-230 miles operating range*
3.2 hrs charge time**

CATALYST E2 MAX
660
kWh

E2 MAX

**E2
MAX**

660 kWh energy on board
213-328 miles operating range*
4.5 hrs charge time**

*Operating range and efficiencies approximated from simulations based on UDDS cycle Altoona testing results at SLW, and will vary with route conditions, weather, vehicle configuration and driver behavior.
**Charge time will vary depending on charger type.

SMARTER CHARGING

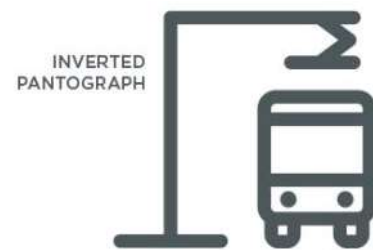
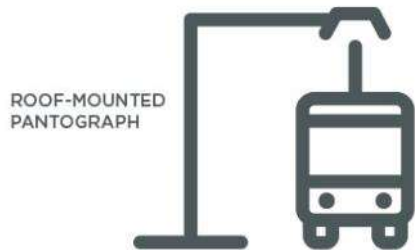
COMPATIBLE WITH INDUSTRY-STANDARD CHARGING SYSTEMS



OVERHEAD CHARGING

Keep your Catalyst buses rolling with easy depot or on-the-road charging, made simple by industry-standard SAE J3105 overhead systems.

- Charge on the road for longer routes or enable 24/7 circulator operations
- Low maintenance costs and high availability
- Compatible with roof-mounted pantographs as well as inverted pantograph systems, offered by Schunk and other suppliers



ADOPTED BY MAJOR OEMS



PLUG IN CHARGING

Regardless of your fleet size, powering up your Proterra buses at the depot is as easy as plugging in a standard J1772-CCS Type 1 charger.

- Universal chargers are offered by Proterra and other suppliers
- Catalyst vehicles can be configured with two charge ports for flexibility at the depot
- Electric buses, utility vehicles and cars can share the same standardized chargers



ADOPTED BY MAJOR OEMS



SMARTER CHARGING PROTERRA POWER CONTROL SYSTEMS



60KW

For fleets with longer available charge times.

Catalyst charge time:
~6 hours



125KW

For fleets with high uptime requirements

Catalyst charge time:
~3 hours



500KW

For fleets with extended operating hours and high mileage requirements

Catalyst charge time:
~30 miles per 10 minutes



Open source communications protocol



Bi-directional V2G capability



Smart grid ready



Telematics-enabled

INTELLIGENT

Automated and rules-based vehicle charging

UNIVERSAL

Standards-based, OCPP 1.6 open communications protocol-compatible

REMOTE

Can be located up to 500 feet from dispenser

SCALABLE

Can be installed side-to-side and back-to-back for high-density charger banks

COMPATIBLE CONNECTIONS



PANTOGRAPH



INVERTED PANTOGRAPH



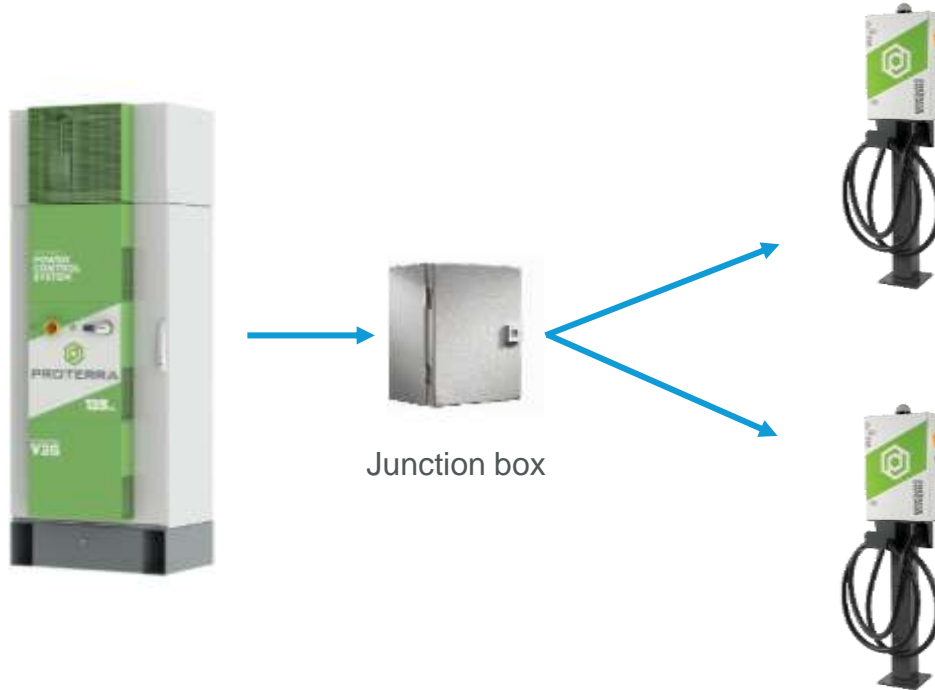
UNIVERSAL PLUG-IN



125 kW PCS

CHARGING DISPENSERS

- **Proterra charging systems can have multiple dispensers paired with a single Power Control System (PCS)**
 - Available for the 60 kW and 125 kW systems
 - Enables automated **sequential** charging
- **Lowers cost of infrastructure**
 - Less hardware to purchase
 - Less major equipment to install
- **Reduces space needed for charging systems**
 - Optimal for space-constrained depots



CHARGES FIRST

- First bus that was plugged in gets charged fully in 3.2 hours at full power of 125 kW

CHARGES SECOND

- When the first bus is finished charging, power is automatically sent to the second dispenser
- Second bus that was plugged in also gets charged fully in 3.2 hours at full power of 125 kW

TWO BUSES CHARGED FULLY IN 6 AND A HALF HOURS USING ONE PCS

- Historically **(PILOT)**

- Manually collect GPS data
- Only applies to single route
- Data only collected for a few routes
- Sufficient for Pilot approach

- The Problem

- Buses operate on Block Schedules (combination of routes) NOT single routes
- How do you replace a legacy fleet when “Energy Demand” for each Block Schedule is unique?

- Fleet Replacement Model **(FULL FLEET CONVERSION)**

- *GPS data for full fleet of legacy buses*
- *Applies to entire Block Schedule (Route Agnostic)*
- ***Allows Full Fleet Electrification***

Pilot Approach vs. Full Fleet Conversion





Proterra works closely with customer to recommend the [appropriate charging solution](#) for fleets and facilities planning for scale as the demand for charging increases.

By providing a full suite of charging products and services in-house, Proterra offers **a comprehensive solution** to help you meet your electrification goals.

INTRODUCING PROTERRA ENERGY FLEET SOLUTIONS

TURNKEY ENERGY DELIVERY FOR ELECTRIC FLEETS



PROTERRA ENERGY™

FLEET SOLUTIONS

By providing a full suite of Proterra products and services in-house, we offer a **comprehensive solution** to help you meet your electrification goals.

- **SOPHISTICATED PLANNING**
- **TURNKEY INFRASTRUCTURE INSTALLATION**
- **SMART ENERGY MANAGEMENT**
- **ADVANCED ENERGY STORAGE**
- **PAY-AS-YOU-GO**



SOPHISTICATED PLANNING FOR SUCCESSFUL ELECTRIC BUS IMPLEMENTATION

Beginning with a high-fidelity route simulation, fleet modeling and detailed TCO analysis, Proterra helps you choose the right vehicle, battery and charging configurations to meet your route requirements now and as you scale.

- **CUSTOMIZED BLOCK SCHEDULE SIMULATION AND FULL FLEET ANALYSIS**
- **INFORMED VEHICLE SELECTION**
- **FLEET MODELING AND CHARGING NEEDS**
- **COST OF OWNERSHIP EVALUATION**



THANK YOU!
Q&A



PROTERRA

