ALEXANDRIA TRANSIT COMPANY

ZERO EMISSIONS

ELECTRIC BUS PROGRAM

DASH OVERVIEW

- Local Bus System for the City of Alexandria, VA
- Services City of Alexandria and surrounding areas
- Operates over 3 million miles annually
- Roughly 4 million annual passengers
- Fleet of 115 fixed route buses
- Service area of 15 square miles

FLEET STRATEGY – ROADMAP TO ZERO EMISSIONS

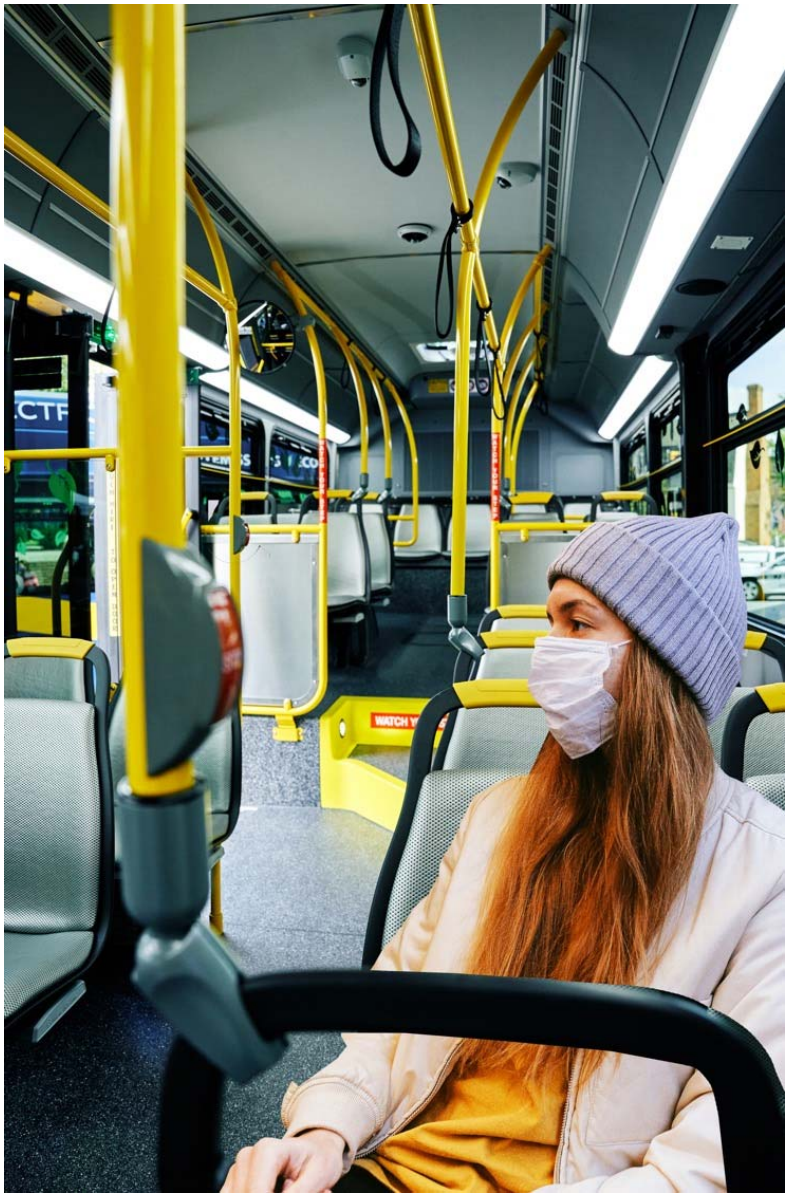
2010: Policy adopted to purchase Diesel-Electric Hybrids for new fleet

2017: Policy change to purchase Clean Diesel instead of Hybrid for short term new fleet.

2019 – 2027: Progressive transition to purchase more Zero Emissions and less Clean Diesel buses with each bus procurement

2027: All new bus procurement to be 100% zero emissions only

2037: 100% of the fleet to be converted to Zero Emissions



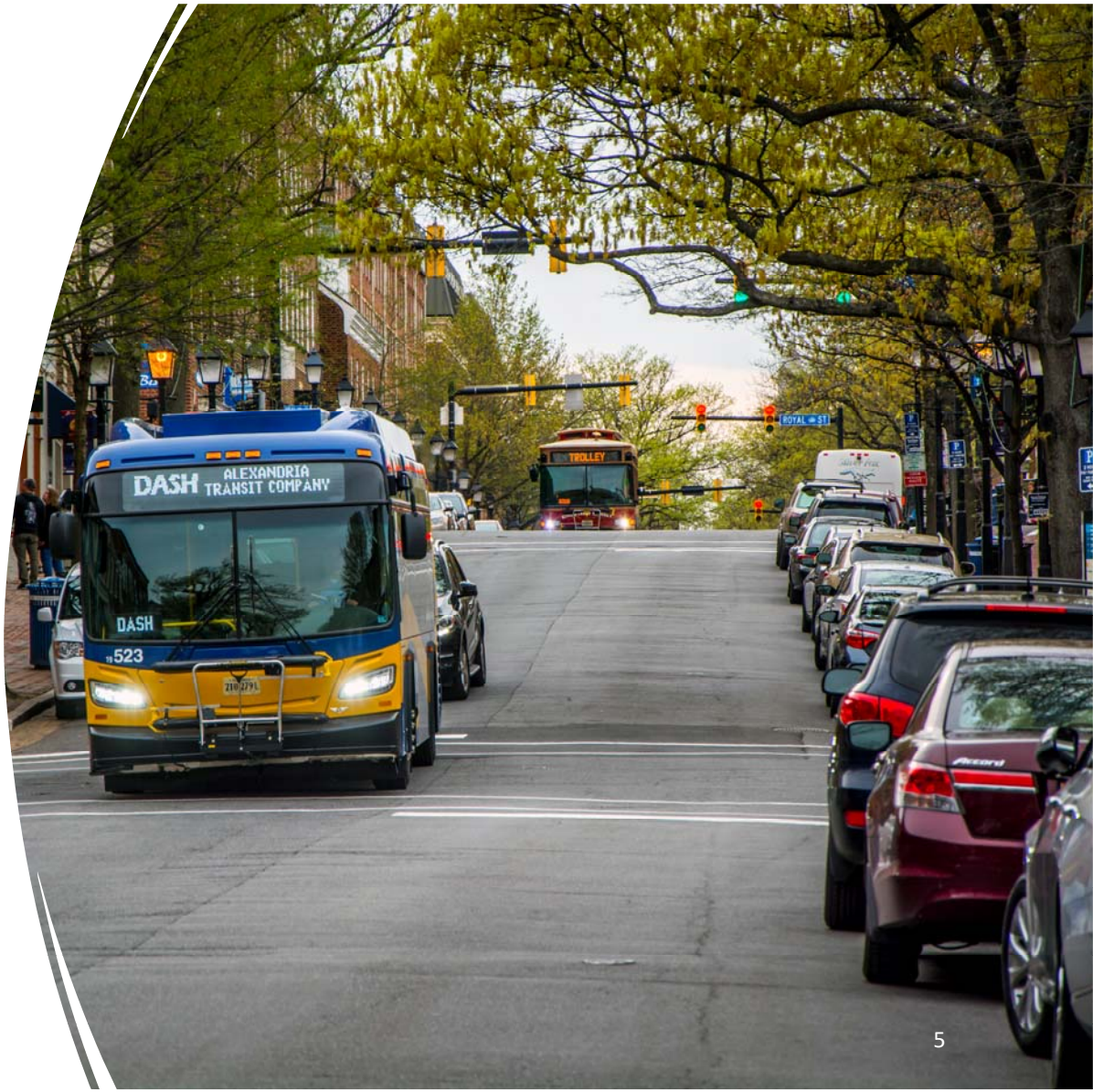
STUDIES AND RESEARCH

- ZEB Feasibility Study (Completed 2019) – CTE
- ZEB Implementation Study Phase 1 (Completed 2021) - WSP
- ZEB Implementation Study Phase 2 (In Progress)
- Future studies to evaluate performance of vehicles, driver habits, and other metrics from the fleet

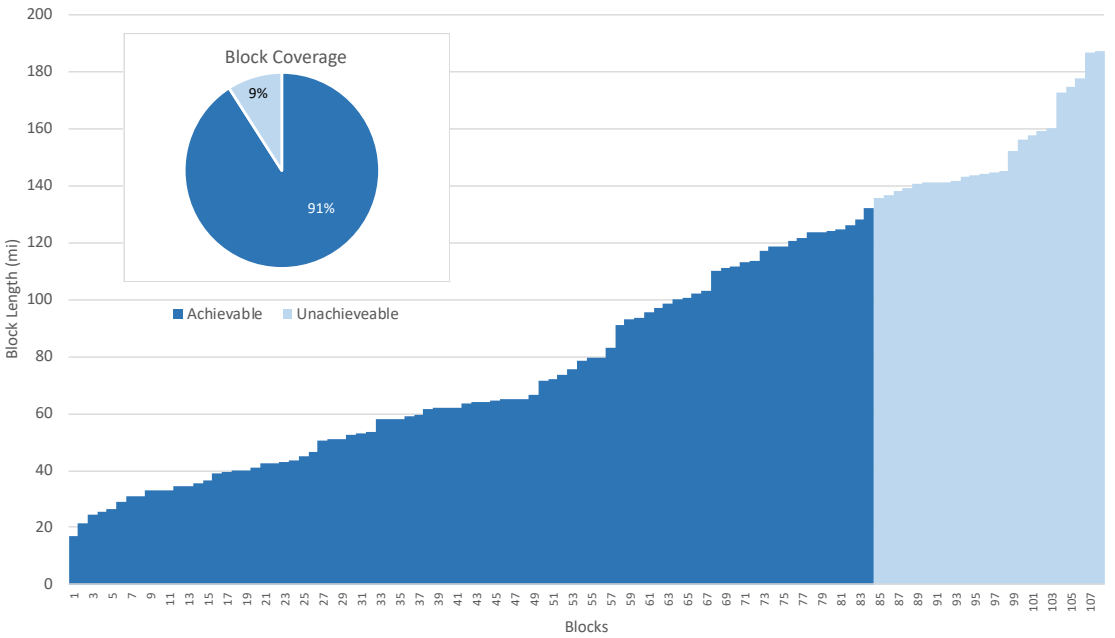
FEASIBILITY STUDY FINDINGS

- Battery Electric is most feasible technology to achieve Zero Emissions given DASH's facilities, fleet, and service requirements

- At about 60-70% conversion, 1:1 replacement using depot charger will no longer be feasible



BLOCK COVERAGE CHALLENGES



Option	Advantages	Disadvantages
Add buses	Consistency of bus & charging technology, scheduling flexibility	Costs associated with a larger fleet*
On-route charging	Allows longer range away from depot, spread electricity demand across the day/locations	Up front cost, permitting, location restrictions, may still require adding buses*
Fuel cell buses	Range allows for 1:1 replacement of older buses	Cost is high, requires H2 fueling infrastructure

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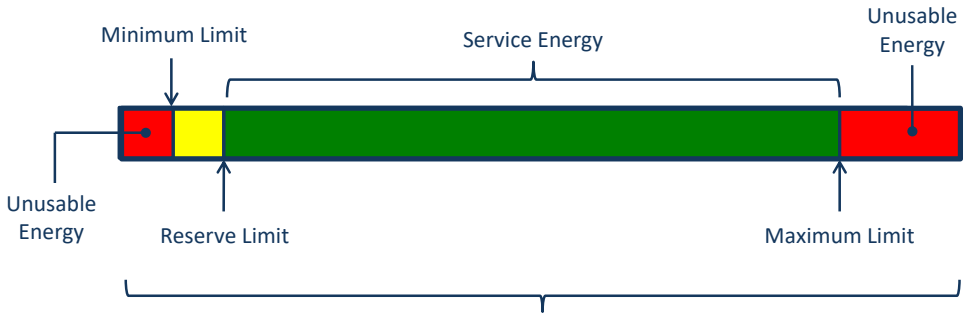
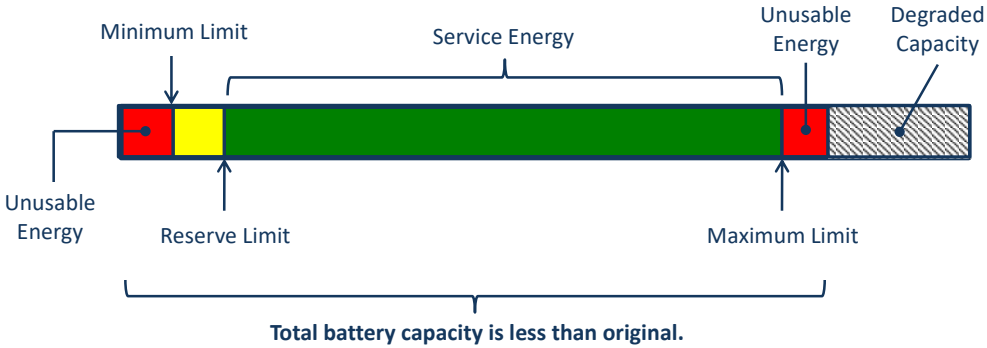
BATTERY CHARACTERISTICS

NEW BATTERIES





BATTERIES AT END OF LIFE

BROCHURE RANGE =/= USABLE RANGE

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APPROACH AND ACTIVITIES

- Strategic Discussions with Local Committees and Organizations
  - Environmental Policy Commission
  - Board of Directors
  - City Council
  - Transportation Commission
- Visiting Manufacturers
  - New Flyer (Aniston, AL & St. Cloud, MN)
  - Proterra (Greenville, SC & San Francisco, CA)
- ZEB Conferences

- Revenue Service Demo's
  - New Flyer
  - Proterra
  - ENC (Fuel Cell)
- Collect Demo Data
- Visit Peers (i.e. DC Circulator)
- Attend webinars and information sessions whenever possible

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FACTORS AFFECTING RANGE

- **Route characteristics:** speed, stops, grade

- **Ridership**

- **Weather – Climate**

- **Heating and cooling.** (Heat is no longer “free.”)

- **Battery degradation**

- **Operator Driving Behavior**

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CURRENT DEPLOYMENT BUSES

Proterra

- (7) 40’ ZX5, 440kWh
- Requirement for interoperability with ABB Chargers

New Flyer of America

- (3) 40’ XE40, 466kWh
- (4) 60’ XE60, 524 kWh
- Requirement for interoperability with Proterra Chargers

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CURRENT DEPLOYMENT - CHARGERS

- ABB
- (3) 150 KW Chargers
- 6 Dispensers Total
- Sequential Charging

- Proterra (Rhombus)
- (3) 125 KW Chargers
- 6 Dispensers Total
- Sequential Charging

DEPLOYMENT GOALS

- Divide risk
- Motivate manufacturers for performance
- Evaluate differing approaches and engineering
- Demonstrate standardization and interoperability

SUCCESSES & CHALLENGES

SUCCESSES

- Early buses showing more reliable than diesel counterparts
- In good weather/operating conditions, range has been adequate
- Drivers and Passengers happy with vehicles
- Initial observations (Maintenance cost per Mile)
  - Electric: $.33-.47/mi
  - Diesel: $1.00-1.20/mi

CHALLENGES

- Early adopter challenges: quality, range expectations, build process.
- Heating significantly reduces range.
- Despite standards, interoperability between buses and chargers continue to be an issue.
- Timeframes:
  - Bus build: 9 – 20 months
  - Revenue service: 2-3 months after delivery
  - Chargers can take even longer

NEXT STEPS

- ZEB Implementation Study Phase II
- Pre-design of DASH Facility Expansion / Electric Bus Charging Yard
- Charge Management
- Smart Charging
- Assisted Dispatch
- On-Route Opportunity Charging
- Inductive Charging

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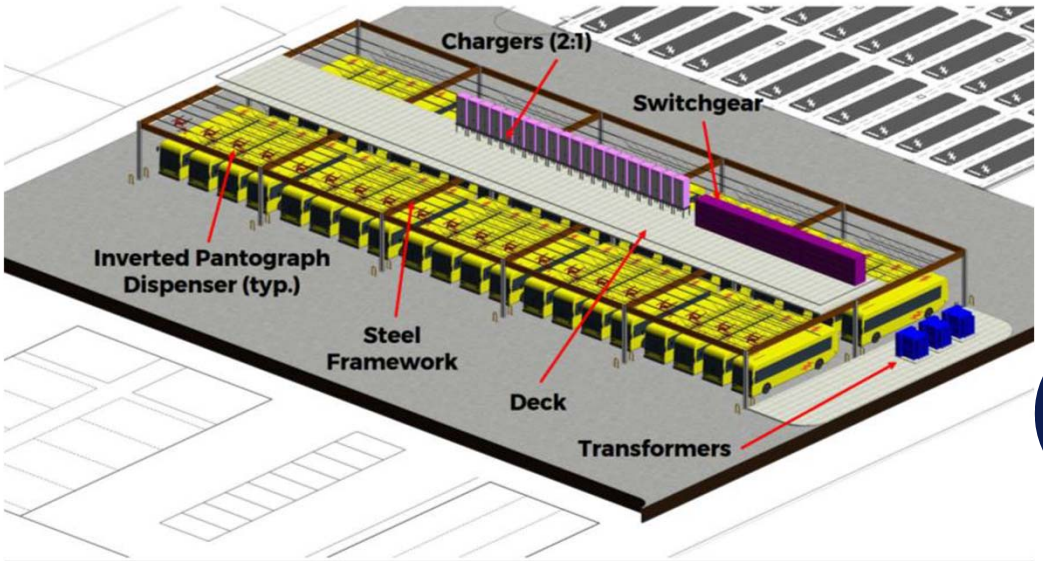
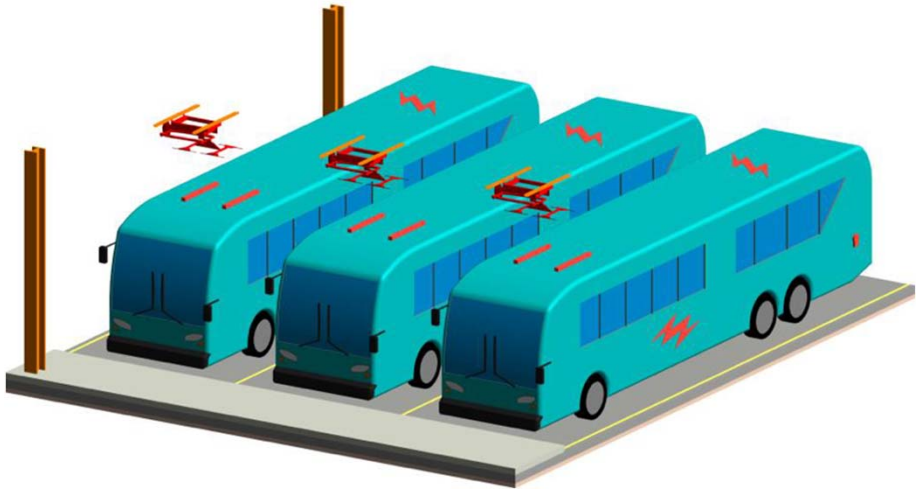
DASH

FACILITY PROGRAM

DESIGN & ENGINEERING





CHARGING STRATEGIES

FACILITY PROGRAM

DESIGN & ENGINEERING

- Initial Scale-Up of up to 6 MW of power
- Expandable to up to 12 MW of power
- Different Charging Configurations Considered
  - 20+ 150 KW Standard Chargers (2:1 Ratio)
  - Up to 20 450 KW Fast Chargers (2:1 Ratio)
  - Lesser amounts of 1.5 MW Megachargers (up to 10:1 Ratio)

CHARGING STRATEGIES

- Need to support ultimately 130+ Buses using no more than 12 MW of power
- Need to support 24/7 Service Profile
- Less chargers at faster output?
- More chargers at slower output?
- How much on-route charge opportunity?

QUESTIONS?

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ZERO EMISSION BUS PROGRAM