Today’s Purpose

• Update Council at the current project milestone
• Provide an opportunity for Council to ask questions
• Solicit perspective from Council members
Schedule

• Feasibility Study and Environmental Assessment
  • May 2023 for Staff
  • July 2023 for City Council

• Space Program
  • Summer 2023
  • On-site visit: August 2023

• Site Master Plan
  • Fall 2023

• Zero Emissions Bus Transition Plan
  • Fall 2023
Going Low- or Zero-Emission

• Charlottesville and Albemarle County implemented a climate action plan
  • Decrease GHG emissions 45% by 2030
  • Reach carbon neutrality by 2050
• There’s substantial funding available for transit agencies in transitioning to ZEBs from Federal Sources
• Market and industry trends are moving towards low- and zero-emission vehicles
CAT’s System Optimization

- 15 Routes
  - 26 operating blocks*
- Serves Charlottesville and urban areas in Albemarle County
- Operating hours typically 6:30am – 11:00pm

* Blocks are equivalent to a vehicle’s work cycle
Factors for Consideration

Resources
- Fuel Sourcing
- Vehicle Costs
- Training
- Funding

Operations
- Ease and Reliability
- Infrastructure Requirements
- Risks
- Flexibility and Scalability
- Administration
- Maintenance

Sustainability
- Environmental Impact (Local)
- Environmental Impact (Global)
- Resiliency
- Alignment with Local/Regional Policy
Technology Feasibility
Produces Emissions

ICE
Internal Combustion Engine

HEV
Hybrid Electric Vehicle

Zero Emissions

BEV
(Battery) Electric Vehicle

FCEV
Fuel Cell Electric Vehicle
Scenarios

• Current: Diesel-only fleet (hybrid transitioning to clean diesel)
• Battery Electric:
  • 1.62:1 replacement ratio, assuming 40% reduction on range
  • Fast Charging, assuming 1 location with multiple bays at Downtown Transit Hub
    • 1:1 replacement ratio, assuming future technology advancements
• Hydrogen
  • Assumes construction of new cryogenic storage and fueling facility
• CNG/RNG
  • Assumes construction of new fueling facility
BEB Range Analysis

225 Mile Stated Range

- Total Run
- Stated Range
- 30% Reduction
- 40% Reduction

Charlottesville Area Transit Facility Design and Zero Emissions Vehicles Feasibility Study
# BEB Transition Potential

<table>
<thead>
<tr>
<th>Routes</th>
<th>BEB Transition Potential</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7s</td>
<td>✓ ✓ ✓</td>
<td>Has the greatest potential of successful operations under a BEB transition</td>
</tr>
<tr>
<td>2A, 3E, 4, 6, 9</td>
<td>✓</td>
<td>Routes can be completed under strenuous conditions</td>
</tr>
<tr>
<td>2B, 3, 10, Trolley</td>
<td>☹ ☹ ☹</td>
<td>Not all operation blocks could be transitioned OR routes could not be completed under strenuous conditions</td>
</tr>
<tr>
<td>1, 5, 7, 8, 11</td>
<td>✗</td>
<td>Cannot be transitioned to BEBs with current technology and blocking</td>
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</table>
Transition Plan Scenarios
Transition Plan Scenarios: Hydrogen, CNG, BEB (*with* fast charging)

- “ZEB” generic term
- **2025** – Two BEBs added to the fleet as expansion vehicles
  - **2028** – Dependent on BEB performance, three planned diesel expansion buses could be swapped for ZEBs
- **2040** – First year for a potential 100% ZEB fleet
  - Assumes 12-year lifespan for buses
Transition Plan Scenarios (continued): BEB (without fast charging)

- Total fleet size of 94 vehicles
  - 1:1.62 Diesel to BEB replacement ratio
  - Replacement ratio based on current block completion analysis
- Total fleet size is dependent on future range improvements for BEBs
Climate and Health Assessment
GHG Emissions

- The initial rise in emissions is due to fleet expansion
  - Peak fleet (58) is achieved in 2028
- 2050 reduction in GHG emissions compared to diesel fleet
  - RNG: 151.4%*
  - BEB: 99.4%
  - Green FCEB: 99.0%
  - Grey FCEB: 38.9%
  - CNG: 7.3%
Carbon Monoxide Emissions

- BEB and FCEB transitions eliminate carbon monoxide emissions
- CNG and RNG transitions increase carbon monoxide emissions by 1050% from diesel fleet
• Emissions based on complete transition and 2050 electrical grid
• FCEB and BEB transitions eliminate local NOx, VOC, and SOx emissions
• CNG and RNG transitions produce the same levels of local pollutants
Comparison of Scenarios
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number of Vehicles</th>
<th>Emissions Reductions</th>
<th>Vehicle Costs</th>
<th>Facility Costs</th>
<th>Operational Costs (Fuel + Maintenance)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>58 (36 Current)</td>
<td>-</td>
<td>$29 M</td>
<td>N/A</td>
<td>$2.2 M</td>
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<tr>
<td>Battery Electric</td>
<td>94</td>
<td>99.4% 6.8%</td>
<td>$83.5 M</td>
<td>$6.3 M</td>
<td>$1.1 M</td>
</tr>
<tr>
<td>Battery Electric w/ Fast Charging</td>
<td>63</td>
<td>99.6% 6.8%</td>
<td>$56 M</td>
<td>$6.3 M</td>
<td>$1.2 M</td>
</tr>
<tr>
<td>Battery Electric (Low-Estimate)</td>
<td>58</td>
<td>99.6% 6.8%</td>
<td>$49 M</td>
<td>$3.7 M</td>
<td>$1.1 M</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>58</td>
<td>99.0% 5.1%</td>
<td>$64 M</td>
<td>$5.7 M</td>
<td>$1.9 M</td>
</tr>
<tr>
<td>CNG (RNG)</td>
<td>58</td>
<td>7.3% (151.4%) 3.1% (10.6%)</td>
<td>$32 M</td>
<td>$2.3 M</td>
<td>$1.2 M</td>
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</table>
Next Steps

• The project will consolidate this discussion into a draft staff-recommended action
• We will document this in our feasibility study for your review and comment
• The project team will present the final revised action to City Council for approval
• The project team will proceed on to conceptual facility design
Questions
Data Backup
Natural Gas Buses

• Range of 400 miles
  • Would complete all of CAT’s current blocks
• CAT could perform a 1:1 transition
• Comparable purchase price to diesel buses
  • Average purchase price is $500,000
• Cheaper to operate and maintain than diesel buses
• No public fueling stations in the area
  • CAT would have to construct an on-site facility
• Natural gas buses are considered low emission
Battery Electric Buses

- Range of 150-350 miles
  - Range significantly affected by external factors - weather, elevation gain, battery degradation, driver aggression, and bus occupancy can all decrease bus range

- Higher purchase price than diesel and natural gas buses
  - Average purchase price of a BEB is $860,000*
  - Costs are likely to increase significantly in 2022 and beyond

- Options include depot charging, on-route charging, or a hybrid
  - Depot charging typically takes 5-8 hours for a full charge
    - One charger can service 1 to 4 vehicles
  - On-route charging can extend vehicle range indefinitely

*This Photo by Unknown Author is licensed under CC BY-SA
Hydrogen – Fuel Cell Buses

• Range of 260-350 miles
  • Less susceptible to range decreases than BEBs
  • Some models may experience weather related degradation

• Refueling takes around 10 minutes

• CAT would likely be able to perform a 1:1 transition

• Higher purchase price compared to BEBs, natural gas, and diesel buses
  • Average cost for a FCEB is $1,150,000

• Closest commercial providers are 300 miles away
  • New Kent DE, Kingsport TN, and Charleston WV
  • On-site hydrogen generation and constructing a hydrogen fueling station is a significant capital expenditure

• FCEBs are still in their infancy, especially for buses under 40’