Metro Transit ZEB Transition
2022 Annual Report

Transportation Committee | September 25, 2023
Carrie Desmond | Manager Electric Bus Infrastructure
Jeremiah Riter | Assistant Director Bus Maintenance
Agenda

• ZEBTP Overview
• Key Performance Indicators
• Project Updates
Transition Plan Guiding Principles

**Technical Viability**
- Strive to achieve a level of service where ZEBs and diesel buses are referred to as just "buses" rather than by their propulsion type
- Partner with Xcel Energy to assess and upgrade electrical infrastructure for bus operations and maintenance facilities

**Equity & Environmental Justice**
- Implement and prioritize ZEB service reflecting transparent fact-driven community engagement and education
- Target ZEB investment in communities where air pollution, racial, and socioeconomic disparities are greatest while also balancing the challenges of new technology

**Fiscal Impact**
- Deploy ZEBs in a fiscally efficient manner in order to maximize use of vehicles and infrastructure
- Operate and invest within fiscal means by planning for and optimizing capital and operating expenditures while pursuing new funding streams
## Transition Plan Guiding Principles – Key Performance Indicators

<table>
<thead>
<tr>
<th>KPI</th>
<th>Technical Viability</th>
<th>Equity &amp; Environmental Justice</th>
<th>Fiscal Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet Mileage</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Bus Reliability</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td></td>
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<td>✓</td>
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</table>
Fleet Mileage

• **What is Being Measured?**
  – The total number of miles driven by ZEBs each year

• **How is it Being Measured?**
  – Total odometer miles for the ZEBs

• **Why is it Important?**
  – As Metro Transit makes progress towards transitioning its fleet to ZEBs, the total number of fleet miles driven by ZEBs will increase. Comparing annual vehicle mileage for ZEBs will help depict how they perform in our service environment
C Line ZEB miles driven reached 90% of scheduled miles in 2022

Percent of ZEB Miles Driven v. Scheduled

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual C Line ZEB Miles*</td>
<td>66,400</td>
<td>162,700</td>
<td>37,800</td>
<td>175,300</td>
</tr>
<tr>
<td>Annual C Line Diesel Miles*</td>
<td>312,600</td>
<td>466,700</td>
<td>625,200</td>
<td>476,900</td>
</tr>
</tbody>
</table>

* Values rounded to the nearest 100
60’ ZEBs travel fewer miles than comparable diesel buses

2022 Miles Per Bus by Type

<table>
<thead>
<tr>
<th>Miles</th>
<th>Electric 60' (BRT)</th>
<th>Diesel 60' (BRT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21,914</td>
<td></td>
<td>36,868</td>
</tr>
</tbody>
</table>

Annual VMT per Person (7-County Metro, 2021)
Bus Reliability

• **What is Being Measured?**
  – Mean (average) distance between chargeable roadcalls.
    • Chargeable road calls are defined as instances when a bus requires unplanned maintenance attention while in service.

• **How is it Being Measured?**
  – Number of miles traveled divided by the number of chargeable roadcalls

• **Why is it Important?**
  – The **Bus Reliability** metric will help Metro Transit evaluate how often a bus breaks down while in service to assess the impact ZEBs have on service reliability and customer experience.
ZEB reliability increased nearly 4x from 2019 to 2022

ZEB Mean Distance Between Chargeable Roadcalls

<table>
<thead>
<tr>
<th>Mean Distance Between Chargeable Roadcalls</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>60’ ZEB BRT Buses</td>
<td>1,270</td>
<td>4,281</td>
<td>2,763</td>
<td>4,870</td>
</tr>
<tr>
<td>60’ Diesel BRT Buses</td>
<td>8,247</td>
<td>8,656</td>
<td>5,201</td>
<td>8,862</td>
</tr>
</tbody>
</table>
Environmental Impact

• **What is Being Measured?**
  – Greenhouse gas (GHG) emission reductions compared to a baseline diesel fleet

• **How is it Being Measured?**
  – Well-to-Wheel GHG reductions calculated using the Argonne National Laboratory’s 2020 Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) model

• **Why is it Important?**
  – The *Environmental Impact* metric quantifies the impact the transition towards ZEBs has on reducing transit vehicle emissions and demonstrates the community benefits that ZEBs deliver to the region
Buses contribute less than 2% of Minnesota’s transportation greenhouse gas emissions

Source: 2020 Sector Sources of GHG Emissions and Storage, Minnesota Pollution Control Agency. Accessed May 2023
Through 2022, ZEB deployments have reduced GHG emissions by 370 Metric Tons CO₂e.

This is equivalent to the CO₂ emissions from:

- **36,149** gallons of diesel consumed
- **71.6** homes' electricity use for one year
- Charging nearly **44,764,500** smartphones

Conversion Source: [EPA Greenhouse Gas Equivalencies Calculator](https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator)
Equity and Environmental Justice (EEJ)

• **What is Being Measured?**
  – Percent of ZEB deployments on “High Priority” EEJ service blocks as defined in Section 8.3.2 of Metro Transit’s Zero-Emission Bus Transition Plan (February 2022)

• **How is it Being Measured?**
  – ZEB deployments on “High Priority” EEJ service blocks divided by the total number of ZEB deployments

• **Why is it Important?**
  – The *Equity and Environmental Justice* metric will help Metro Transit understand the impact ZEB deployment prioritization is having in the community based on environmental, racial, and socioeconomic considerations
High Priority service blocks have the greatest portion of bus mileage in High Priority (pink) EEJ Areas

<table>
<thead>
<tr>
<th>Component</th>
<th>% of Census Tract EEJ Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer Risk</td>
<td>34%</td>
</tr>
<tr>
<td>Population Density</td>
<td>22%</td>
</tr>
<tr>
<td>% BIPOC</td>
<td>17%</td>
</tr>
<tr>
<td>% Zero Car Household</td>
<td>11%</td>
</tr>
<tr>
<td># of Years Area of Concentrated Poverty</td>
<td>9%</td>
</tr>
<tr>
<td>Avg. Land Temperature</td>
<td>4%</td>
</tr>
<tr>
<td>% Housing Cost Burdened</td>
<td>3%</td>
</tr>
</tbody>
</table>
In 2022, 100% of ZEB deployments were on “High Priority” EEJ blocks
Energy Cost/Mile

• **What is Being Measured?**
  – Energy cost a bus uses to travel one mile inclusive of propulsion energy (diesel or electricity) and diesel fuel for bus auxiliary heat

• **How is it Being Measured?**
  – The total energy cost by vehicle group divided by the total miles traveled by that group

• **Why is it Important?**
  – The *Energy Cost/Mile* metric will help Metro Transit understand the ongoing costs and necessary budget to operate ZEBs
Average annual energy costs per mile are historically higher for ZEBs than diesel buses.

<table>
<thead>
<tr>
<th>Year</th>
<th>ZEB</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>$0.57</td>
<td>$0.94</td>
</tr>
<tr>
<td>2020</td>
<td>$0.38</td>
<td>$0.99</td>
</tr>
<tr>
<td>2021</td>
<td>$0.55</td>
<td>$1.12</td>
</tr>
<tr>
<td>2022</td>
<td>$1.02</td>
<td>$1.17</td>
</tr>
</tbody>
</table>
Infrastructure Availability

• What is Being Measured?
  – Percent of chargers available to charge a bus for revenue service

• How is it Being Measured?
  – Total number of days each charger is available to support deploying buses in revenue service divided by the total number of planned service days

• Why is it Important?
  – Historically fuel pump availability was not a concern, however early charger deployments have had lower availability. The Infrastructure Availability metric will help Metro Transit assess technology ability to consistently provide reliable service.
In 2022, all charger locations achieved an average availability greater than 95%.

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug-In: Heywood Garage</td>
<td>93%</td>
<td>22%</td>
<td>99.8%</td>
</tr>
<tr>
<td>On-Route: BCTC</td>
<td>62%</td>
<td>87%†</td>
<td>96%</td>
</tr>
</tbody>
</table>

* Metrics not reported for 2019 while commissioning was ongoing
† 2021 On-Route Charger availability reflects data from 1/1/21 – 3/2/21 when ZEBs were in-service
Infrastructure Reliability

• **What is Being Measured?**
  – The quantity of incidents that take a charger out of service

• **How is it Being Measured?**
  – **Incident Quantity**: Number of incidents that take a charger out of service

• **Why is it Important?**
  – The **Infrastructure Reliability** metric will help Metro Transit understand how often chargers must be temporarily removed from service for unplanned maintenance. This will help Metro Transit assess technology ability to consistently provide reliable service.
Out-of-service incidents are decreasing for garage (plug-in) chargers and increasing for on-route chargers.

Note: Metrics not reported for 2019 while commissioning was ongoing. 2021 On-Route charger reliability reflects data from 1/1/21-3/2/21 when ZEBs were in service.
# Zero-Emission Bus (ZEB) KPI Summary

## 2021 - 2022 Summary

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<th>Battery Electric 2022**</th>
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<td><strong>Fleet Mileage</strong>*</td>
<td>37,800</td>
<td>175,300</td>
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<tr>
<td><strong>Bus Reliability</strong> &lt;br&gt;(Mean Distance Between Chargeable Road Calls)</td>
<td>2,763</td>
<td>4,870</td>
</tr>
<tr>
<td><strong>Environmental Impact</strong>** &lt;br&gt;(GHG [CO₂e] Reduction in Metric Tons)</td>
<td>10</td>
<td>145</td>
</tr>
<tr>
<td><strong>Equity and Environmental Justice (EEJ)</strong> &lt;br&gt;(Percent of BEB Deployments on “High Priority” EEJ Blocks)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Energy Cost/Mile</strong></td>
<td>$1.12 &lt;br&gt;($0.55 for diesel bus)</td>
<td>$1.17 &lt;br&gt;($1.02 for diesel bus)</td>
</tr>
<tr>
<td><strong>Infrastructure Availability</strong> &lt;br&gt;(Average Full Days Available to Charge a Bus for Use in Revenue Service)</td>
<td>Garage: 22% &lt;br&gt;On-Route: 87%</td>
<td>Garage: 99.8% &lt;br&gt;On-Route: 96%</td>
</tr>
<tr>
<td><strong>Infrastructure Reliability</strong> &lt;br&gt;(Total incidents that take chargers out of service)</td>
<td>Garage: 19 &lt;br&gt;On-Route: 10</td>
<td>Garage: 2 &lt;br&gt;On-Route: 21</td>
</tr>
</tbody>
</table>

* In calendar year 2021, ZEBs were out-of-service March-November

** Green cells or text indicate an improvement or consistent performance since 2021 while orange cells or text represent a decline

*** Rounded to the nearest 100 miles

**** Rounded to the nearest 5 Metric Tons
January to June 2023 Preliminary Findings

• Numerous bus high voltage battery cell replacements
  – 70% of scheduled ZEB miles driven

• On-route charger reliability continues to be a challenge
  – BCTC chargers out of service June 15 - present

• Continue to have 100% BEB deployments on high-priority EEJ blocks

• Energy cost per mile continues to be higher for BEBs compared to diesel
FTA awards Metro Transit $17.5M for FY23 Low/No

Announcing:

New funding for zero-emission buses!
Project Updates: Workforce Development

- Bus Maintenance Mechanic Technician Apprentice Program
- Infrastructure training & SOP development
- Peer exchange
- Formalized Electric Bus Infrastructure team with 3 staff
- Hiring Program Manager Bus Technologies
Project Updates: North Loop Garage

• Service started March 2023

• Built to accommodate electric bus technology, capacity for a growing zero-emission fleet

• 20 40ft Battery-electric buses in procurement for regular service routes

• 23 chargers (20 depot, 3 mobile)

Switchgear to power future BEB power cabinets
Project Updates: East Metro Garage

• 5 60-foot electric buses and chargers for Gold Line
• Working with Xcel for new power feeders and exterior site preparation
• Anticipate additional 40-foot electric buses after Gold Line
Engagement

• In 2022…
  – 13 events, tours or speaking engagements
  – 20 peer exchanges
  – 13 vendor meetings
  – 5 industry work groups & committee assignments

• Through August 2023…
  – 12 events, tours or speaking engagements
  – 10 peer exchanges
  – 6 vendor meetings
  – 4 industry work groups & committee assignments

• Save the Date
  – Stakeholder ZEBTP Update Summits
    • Oct. 26: 6pm
    • Oct. 27: 12pm

EV Day at the Capitol
Thank You!

Carrie Desmond
Carrie.Desmond@metrotransit.org
612-349-7798

Jeremiah Riter
Jeremiah.Riter@metrotransit.org
612-349-5005

www.metrotransit.org/electric-buses