Zero-Emission Transition Study

January 22, 2025 - **DRAFT**

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CONNECT

Public Transit

- Introduction
- Zero Emission Bus - Market Overview
- Case Studies and Interviews With Peer Agencies
- Key Points From Peer Review
- Implementation Planning
- Conclusion and Recommendations

Introduction

Considerations in deciding to pursue a zero-emission fleet transition

- Compiled industry best practices and market trends
- Interviewed peer agencies

Data to support Connect in making informed decisions

- Real-world operating performance
- Transition costs
- Operational impacts
- Workforce development
- Best practices and lessons learned

Understanding why agencies are making the move to zero-emission buses

- State, regional, and local mandates
- Availability of Federal Funding
- Air quality improvement goals

Market Overview

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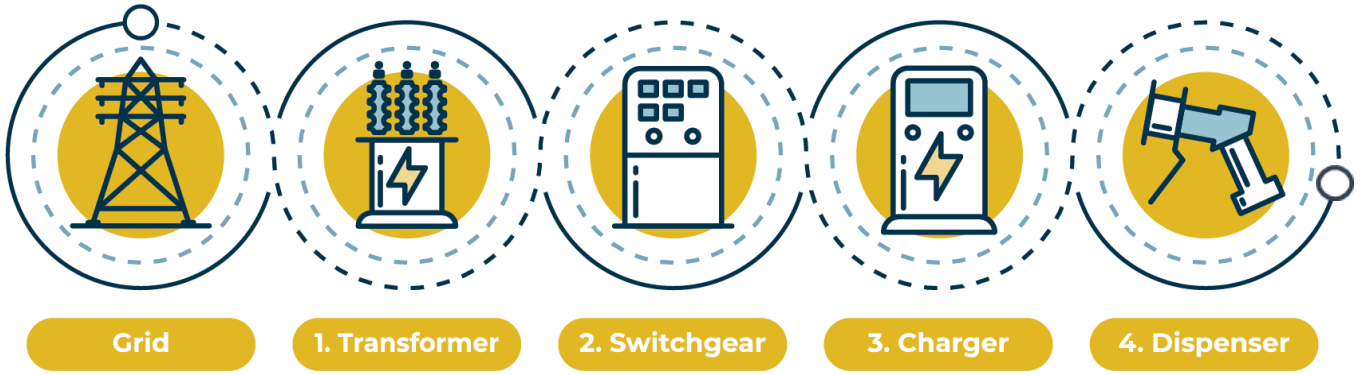
Zero Emission Vehicle Technologies

Battery Electric Bus (BEB)

Range: 150 – 250 miles

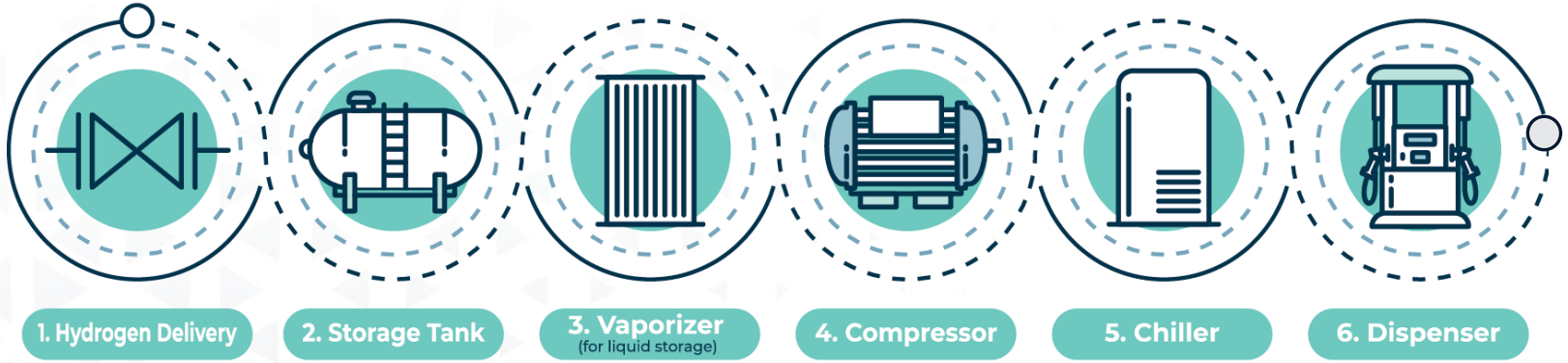
Charge stored in an onboard battery pack



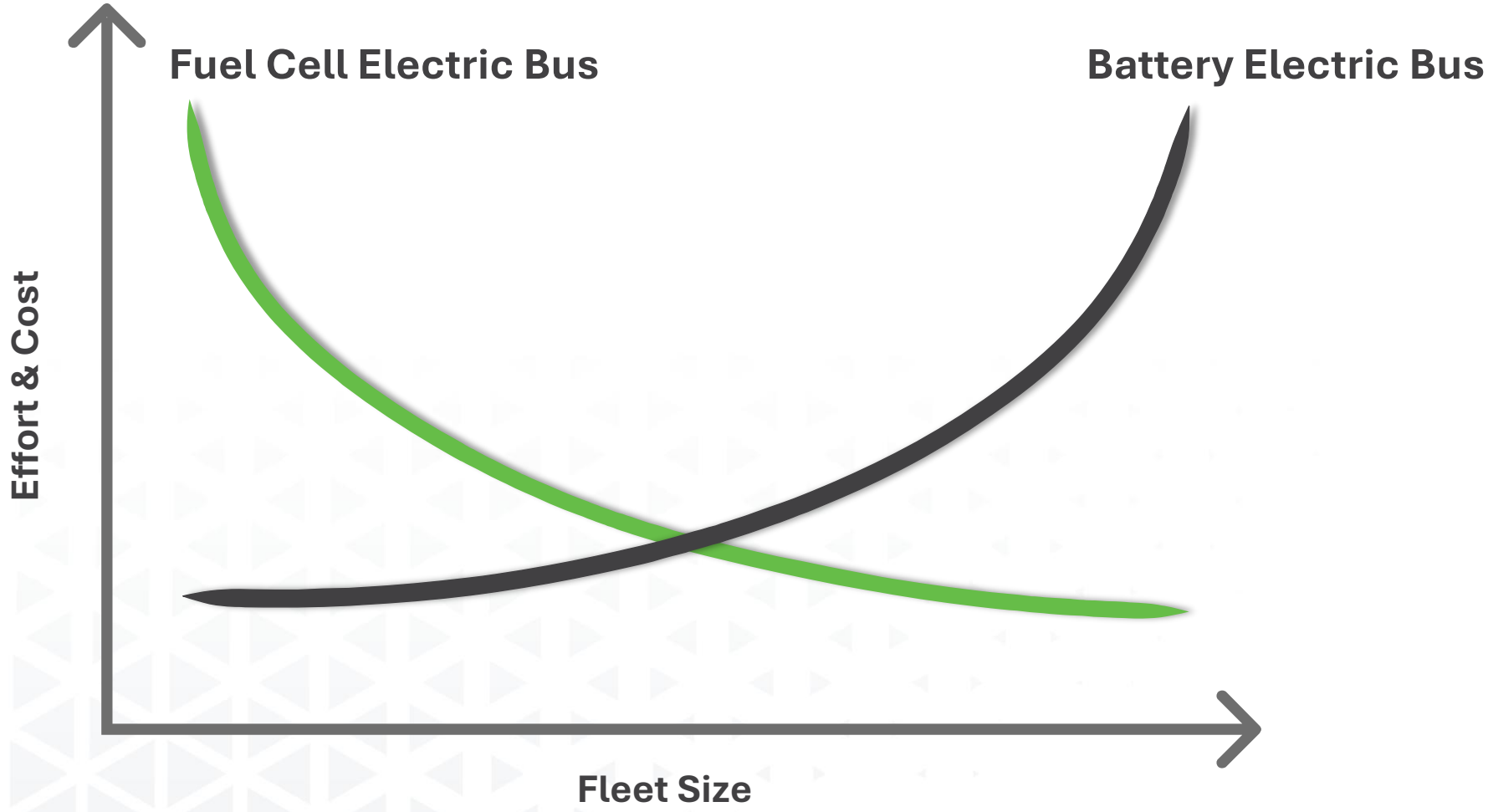
Fuel Cell Electric Bus (FCEB)

Range: 350+ miles

Charged during vehicle operations using on-board stored hydrogen fuel



Scaling Fueling/Charging Infrastructure



Vehicle Technologies

	BEB	FCEB	Diesel Hybrid	Diesel
Vehicle Range (per OEM)	**150 – 250 miles**	**350 miles**	**500 miles**	**450 Miles**
Fueling/Charging Time*	~5 – 8 hours	~20 minutes	~20 minutes	~20 minutes
Vehicle Purchase Price	$850,000 - $1,000,000 +	$1,000,000 +	$700,000 - $830,000	$550,000
Infrastructure Cost	$69,000 per depot charger/bus**	$4.7 million for 50 buses***	Uses existing infrastructure	Uses existing infrastructure
Operations and Maintenance Cost	lower	higher	moderate	moderate

*Assuming depot slow-charging of BEB, highly variable based on charger power and battery size
**Does not include other costs associated with addition of chargers, including potential transformer, substation, and conduit upgrades
***Based on OCTA's 18,000-gallon liquid storage Hydrogen station, built in 2019

Peer Interviews

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Peer Agencies

Identified four agencies with:

- Similar climate considerations
- Similar Fleet Size
- Diverse ZEV technologies
- Various stages of transition

Mountain Line

MTD thrive

High Valley TRANSIT

MOUNTAIN LINE

Connect Transit

Logan, Utah

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Fleet: 29 vehicles for fixed route service, eight paratransit vehicles; three microtransit vehicles

Climate: Average summer high: 88°F ; Average winter low: 11°F

Service Characteristics: Longest route is 335 miles; average weekday route is 197 miles (excluding special event service)

Mountain Line

Missoula, Montana

Battery Electric Bus (BEB)

Fleet: 30 vehicles for fixed route service, up from 25 previously, including 12 electric buses

Climate: Average summer high: 86°F ; Average winter low: 17°F

Transition Experience: Began transition in 2019; expected to be 90% electric by end of 2026

Observed Range: In cold weather 50-80 miles; mild weather 150-160 miles

Key Challenges and Solutions

- **Range anxiety for electric buses is addressed by adjusting the operational duty of each bus to match what it is capable of driving in a day, ultimately increasing the total number of vehicles in the fleet**
- **Have staff data analyst to decipher vehicle data**

Mass Transit District

Champaign-Urbana, Illinois

Fuel Cell Electric Bus (FCEB)

H^2

MTD thrive

Fleet: 12 fuel cell electric buses; 106 diesel-electric

Climate: Average summer high: 84°F ; Average winter low: 16°F

Transition Experience: Began operating FCEBs in 2021; MTD produces Hydrogen Fuel on-site with solar-powered electrolyzer

Observed Range: Est. 300 miles from 40' FCEB; 200 miles from 60' FCEB

Key Best Practice:

- **Train a core group of technicians who can work on the new technologies and ensure they get regular time spent working on these vehicles.**

High Valley Transit

Wasatch Back, Utah

Battery Electric Bus (BEB)

High Valley TRANSIT

Fleet: 32 buses, including eight Gillig electric buses

Climate: Average summer high: 83°F ; Average winter low: 9°F

Transition Experience: First deployed electric buses in 2023. Fleet is currently 25% electric.

Observed Range: 80 to 120 miles for current buses. New buses with larger battery are expected to have range around 200 miles.

Best practices and recommendations:

- **Explore the potential to deliver additional charge to the bus throughout the day by opportunity charging at layover locations.**

Mountain Line

Flagstaff, Arizona

Battery Electric Bus (BEB)

Fleet: 30 fixed-route vehicles, including two electric buses

Climate: Average summer high: 81°F ; Average winter low: 10°F

Transition Experience: Hybrid fleet since 2017, electric buses added in 2023

Observed Range: 100 miles predictably, 190 miles under best circumstances

Best practices and recommendations:

- **Eliminate on-route shift changes—each operator pulls out a new bus.**

Summary

Peer Agencies Identified	connect public transit	Mountain Line	MTD thrive	High Valley TRANSIT	MOUNTAIN LINE
Number of Fixed-Route Buses	29	30	118	32	30
Percent of Fleet Zero-Emission	-	43%	11%	25%	6%
Technology	Diesel	BEB	FCEB	BEB	BEB

Takeaways

- BEBs have limited ranges that would likely require operational changes.
- A ZEB Transition is expensive - vehicles are roughly double the price of diesel buses.
- FCEBs have longer ranges, but the infrastructure cost is likely prohibitive at Connect's fleet size.

Challenges

- High initial capital costs to update or upgrade facilities.
- Difficulties finding skilled labor to maintain the chargers.
- BEBs have constrained ranges, often requiring fleet expansions or route and service adjustments.
- Additional safety considerations with an FCEB deployment, especially regarding fuel production, delivery, and storage.

Key Points From Peer Review

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Key Points From Peer Review

- Reduced or eliminated tailpipe emissions
- Better fuel efficiency
- Quieter buses

- Highly variable vehicle range
- Increased vehicle purchase price
- Operational adjustments likely required
- Facility conversion capacity constraints

Implementation Planning

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Implementation Planning

Phased Approach

- **Short-term**
  Planning, initial pilot projects, and infrastructure setup.
- **Medium-term**
  Expansion of zero-emission vehicles and infrastructure.
- **Long-term**
  Full transition and optimization.

Stakeholder Engagement

- **Engage early and often** with utility, policymakers, operations staff

Risk Management

- **Identify and mitigate** potential risks early in the process

Implementation Planning

Transition Strategy

Fleet Plan

Demonstrate a long-term fleet management plan with a capital spending strategy

Facility Plan

Evaluate existing and future facilities and their relationship to the technology transition

Summary and Recommendations

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Key Takeaways

Market Overview Considerations

- Fuel availability
- Range feasibility for Connect's operations

Peer Agency Interviews

- Use a charge management system to manage and standardize data between manufacturers
- Consider re-bocking routes to account for range limitations
- Operational changes are likely necessary, with each driver shift change requiring a bus swap for a fully-charged bus
- Plan for the long-term necessary infrastructure investments and facility upgrades

Recommendations

- **Perform detailed route analysis to assess feasibility of transition**
- **Examine fleet decommissioning schedule to dial in on potential transition phasing**

Questions?

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