Kimley»Horn

Expect More. Experience Better.

Charlottesville Area Transit Facility Design and Zero Emissions Vehicles

City Council Meeting

January 16, 2024

Project Goals

- Achieve **45%** GHG reduction by 2030; net zero by **2050**
- Determine a preferred cleaner fuel type for CAT
  - Consider trade-offs including operating and capital cost, emissions impact, and operational viability
  - Balance the current level of service with practicality of low or no emissions buses (minimize impact to operations)
  - Consider well-to-wheel impact of propulsion technology on local and global emissions
- Determine high level implementation strategy and timeline of the preferred fuel type

Technology Considerations

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

	Natural Gas (NG)	Battery-Electric Bus (BEB)	Fuel Cell Electric Bus (FCEB)
Propulsion	Uses combustion to provide propulsion through a mechanical drivetrain.	Convert electricity from onboard batteries into propulsion through electric motor.	Convert electricity from both a hydrogen fuel cell and onboard batteries into propulsion through electric motor.
Emissions	Produces less tailpipe GHG emissions than diesel. Certain local emission like CO would increase. RNG would significantly reduce global greenhouse gas emissions.	Produce zero tailpipe emissions.	Produce zero tailpipe emissions.
Refueling/ Recharging	Is refueled identically to existing natural gas buses.	May be charged overnight or fast-charged on route using plug-in, overhead pantograph, or in-ground inductive charging.	May be refueled with hydrogen dispensed from pump.
Training	Requires new training for operators and mechanics.	Requires new training for operators, mechanics, and route planners.	Requires new training for operators and mechanics.
Infrastructure	Requires fuel delivery or pipe hookup and storage. Requires facility space for gas storage, compression, and dispensing equipment.	Requires additional facility space, charging equipment, and infrastructure.	Would require hydrogen fuel delivery and storage or on-site production. Requires facility space for hydrogen storage, compression, and dispensing equipment.

Technology Evaluation

CNG/RNG

+	−
Cost Effective Mature Technology Resilient Operations	Produces Emissions

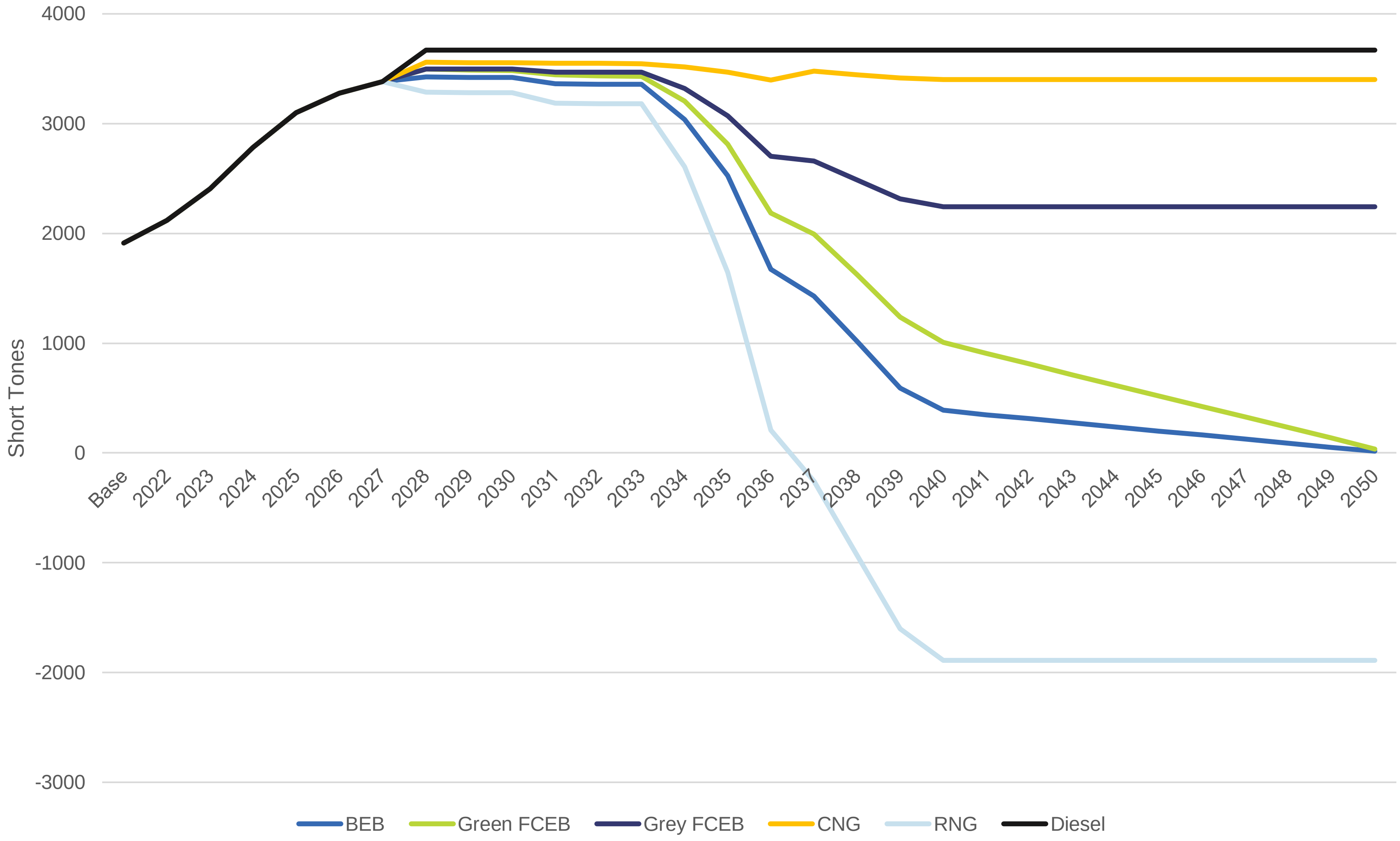
Battery Electric

+	−
Zero Tailpipe Emissions Mature ZEB Technology Definitive Source of Fuel	Large Fleet High Cost Range Concerns

Hydrogen Fuel Cell

+	−
Zero Tailpipe Emissions Resilient Operations	High Cost to Deploy Lack of Fuel Supplier

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 2021's diesel fleet
  - RNG: 151.4%
  - BEB: 99.4%
  - Green FCEB: 99.0%
  - Grey FCEB: 38.9%
  - CNG: 7.3%

Scenario	Number of Vehicles	Emissions Reductions		Vehicle Costs (Local Match)	Facility Costs (Local Match)	Operational Costs [Fuel + Maintenance] (Local Match)
		Long-Term	Near-Term			
Diesel (Baseline)	58 (40 Current)	-		$29M ($1.2M)	N/A	$2.2M ($550K)
Battery Electric	94	99.4%	6.8%	$83.5M ($3.3M)	$6.3M ($300K)	$1.1M ($275K)
Battery Electric w/ Fast Charging	63	99.6%	6.8%	$56M ($2.2M)	$6.3M ($300K)	$1.2M ($300K)
Battery Electric (Low-Estimate)	58-63	99.6%	6.8%	$49M - $56M ($2.0M - $2.2M)	$3.7M - $6.3M ($100K - $300K)	$1.1M - $1.2M ($275K - $300K)
Hydrogen	58	99.0%	5.1%	$64M ($2.6M)	$5.7M ($200K)	$1.9M ($475K)
CNG [RNG]	58	7.3% [151.4%]	3.1% [10.6%]	$32M ($1.3M)	$2.3M ($100K)	$1.2M ($300K)

Regional Example

Arlington (ART)

- 2022-2023 study to evaluate ZEB technologies
  - RNG, BEB, FCEB
- Modeling suggested BEB implementation would require additional buses and scheduling changes
- Space constraints at O&M facilities

Technology	Conditions[1]	Battery Size	Other	Success Rate	Additional Buses
BEB	Summer w/ AC	440 kWh		96.2%	2
	Winter w/ Heat	440 kWh[4]		13.2%	46
	Winter w/ Heat	440 kWh	Auxiliary Heat[2]	92.5%	4
	Winter w/ Heat	550 kWh		62.3%	20
	Winter w/ Heat	440 kWh	On-Route Charging[3]	22.6%	41
FCEB	Summer w/ AC	n/a (Fuel Cell)		100%	0
	Winter w/ Heat	n/a (Fuel Cell)		100%	0

Arlington (ART)

- Many variables and risks, including the pace and costs of technology evolution
- Recommended pilot of both BEB and FCEB technologies

Variables

- Training
- Costs
- Grants & Subsidies
- Technology Evolution

Risks

- Increasing Service
- Service & Equity Considerations
- En-route Charging
- Safety Systems
- Cleaning and Capacity of the Grid
- Code Requirements
- Space Constraints
- Operating Performance

Recommendations

1. CAT will transition to a zero-emissions fleet by 2040, supporting the City's climate goals of carbon-neutral operations by 2050
2. CAT will pilot to two fuel types for transition: battery-electric and hydrogen fuel cell
   1. The BEB pilot will begin with 2 BEBs being purchased in 2024.
   2. Hydrogen fuel cell pilot vehicles will be purchased in 2027
   3. BEB pilot testing will come before hydrogen pilot testing, so there is sufficient time to establish a source for a hydrogen supply or generation.
3. During pilot testing, CAT will continue expanding its fleet to meet the capital requirements of planned service improvements

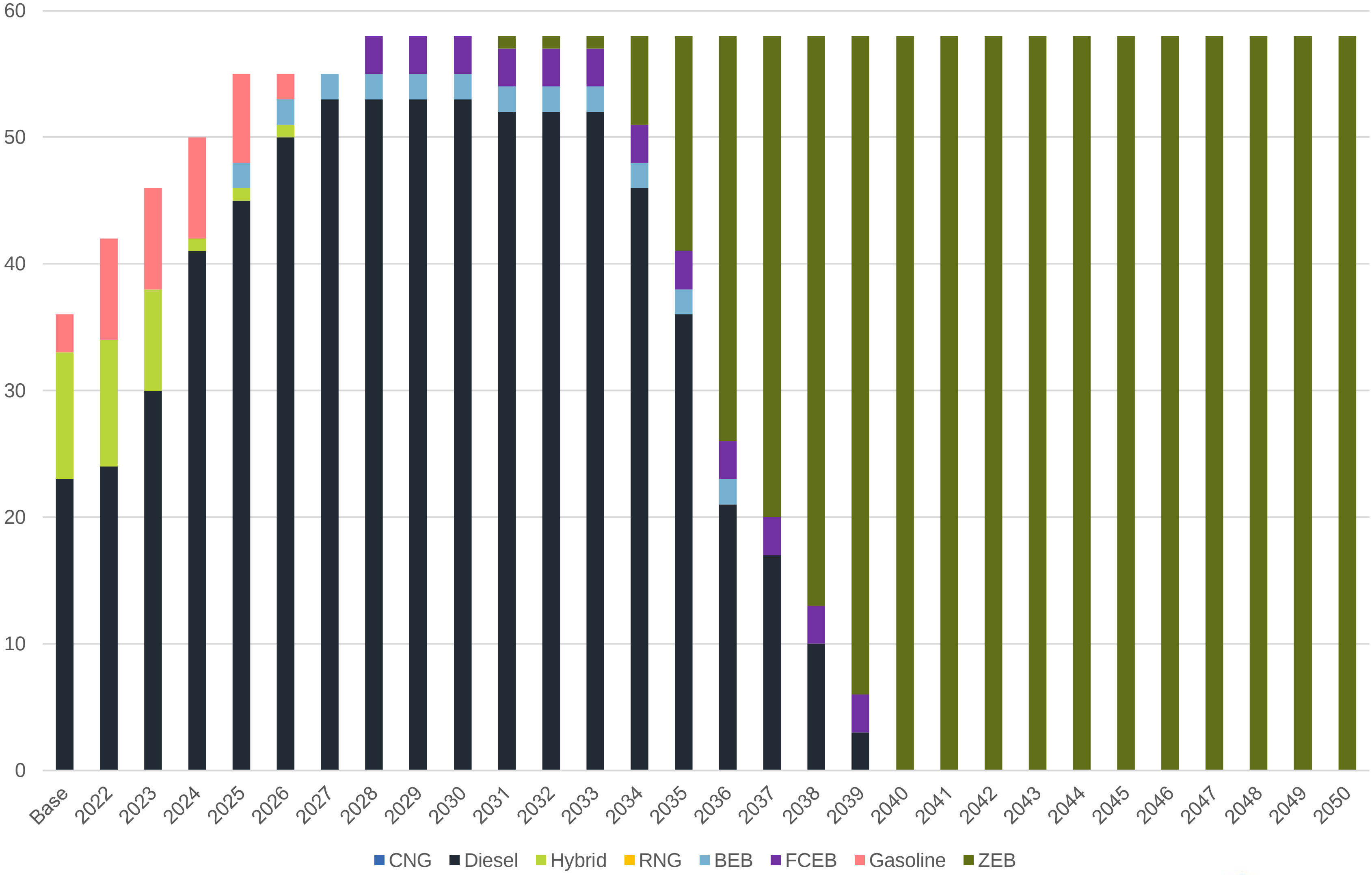
Recommendations Cont.

4. The final fleet mix will be determined through pilot testing and improvements to ZEB technologies. CAT’s chief consideration will be the fleet’s reliability and capital and O&M costs

5. Charging and fueling will take place at the CAT facility
   - The City will identify a source for hydrogen fuel and investigate on-site green hydrogen production as part of the site planning effort.
   - The City will investigate on-site generation of electricity for the charging of BEBs at the CAT facility as part of the site planning effort

ZEB Transition Guide

- 2025 – 2 BEBs added to fleet as expansion vehicles
  - 2028 – 3 FCEBs will be added to fleet as expansion vehicles
- 2040 – First year for a potential 100% ZEB fleet
  - Assumes 12-year lifespan for buses



Next Steps

- Finalize the alternative fuel feasibility study
- Begin the conceptual site design of the CAT facility expansion and additional site improvements
- Complete zero-emissions transition plan requirements for FTA

Discussion