**CLIMATE CHANGE, ENERGY AND ENVIRONMENT COMMISSION**
**c/o Department of Environmental Services**
**2100 Clarendon Blvd., Suite 705**
**Arlington, VA 22201**

December 18, 2023

Honorable Christian Dorsey, Chair
Arlington County Board
2100 Clarendon Blvd., Suite 300
Arlington VA 22201

Dear Chair Dorsey,

The Climate Change, Energy and Environment Commission (C2E2), with the assistance of the Energy Committee (EC), has reviewed the November 2023 Draft Final Report on the ART Zero-Emissions Bus Study, prepared by contractor Kimley Horn.

Based on this review, C2E2 urges the County Board to ensure that any buses ordered in 2024 and beyond are battery-electric buses (BEBs) only.

Key findings supporting this recommendation include:

**Methane-powered buses (our current compressed natural gas (CNG) powered buses)** are not desirable for Arlington because they produce $CO_2$ and other pollutants. There should be no delay in transitioning away from them. CNG and renewable natural gas (RNG) are identical forms of methane, a greenhouse gas more than 80 times more powerful than carbon dioxide measured over a 20-year period.[1] Both forms of methane are equally polluting and equally prone to leakage and incomplete combustion throughout their lifecycle.

**BEBs** are no longer an early adopter technology. They are proven and in use in all neighboring jurisdictions and across the nation. They are the most efficient and cost-effective zero emission bus technology. Arlington will have no difficulty replacing CNG buses with BEBs at a 1:1 replacement ratio if it chooses appropriate battery sizes and follows standard fleet management practices.

**Hydrogen buses**, also known as fuel cell electric buses (FCEBs), are at an early stage of development. They are more costly in every respect than BEBs. Hydrogen technology is also much less energy efficient, making FCEBs less desirable from a climate perspective. The problems with hydrogen are fundamental and will not change with a pilot study. Monitoring this technology in the coming years is appropriate and much less costly than purchasing buses and infrastructure for a pilot.

Each of these findings is discussed in greater detail below.

[1] Stanford Doerr School of Sustainability, "Methane and Climate Change," Nov. 2, 2021.

**BEBs are Feasible and Appropriate for Arlington**.

At its core, the Report, including all of its fleet cost estimates, estimates of facility needs, and recommendations, are based on the route block analysis described in Attachment A of Appendix D: Implementation Plan Technical Memorandum. The analysis concludes that buses with a 550 kWh battery could meet 77 percent of all route blocks and 62 percent of route block pairings (buses generally complete two route blocks per day) even in a scenario that combines extreme cold temperatures with a variety of other challenging conditions. Assessments by the Washington Metropolitan Area Transportation Authority (WMATA) and other jurisdictions, including Alexandria's DASH, have judged similar results as sufficient to justify initiating a transition to BEBs, anticipating continued battery improvements and fleet management strategies will close any remaining gaps.

**Underlying Operating Assumptions**

The 550 kWh battery was modeled under assumptions that included: No change in battery technology between now and 2038; all batteries at end-of-life condition; route block assignments not optimized for success; 30% of total fleet modeled as unavailable for service; 20% of battery capacity modeled as unavailable as a reserve requirement; average temperature 14 degrees Fahrenheit; resistance heating system on "max heat" at all times; and average passenger load assumed to be more than 20 times higher than actual ART System average, adding at least 8,000 pounds of extra weight. These conditions were not well disclosed. We have not found any other study that combines these conditions in a single scenario.

As ART begins the gradual process of integrating these buses into its fleet it will have a number of strategies to ensure reliable service without expanding fleet size even on extreme cold days:

- During the entire time of transition – until the mid-2030s or later – CNG buses will remain in the fleet operating alongside BEBs. These CNG buses will be available to handle any routes that initially prove challenging for BEBs, providing a 1:1 replacement ratio for close to ten years. This practical approach of relying on existing fossil fuel buses while they remain in the fleet is how WMATA,[2] Alexandria, and other peer localities are transitioning their fleets. The Study makes no mention of this approach.
- Arlington can ensure success by buying appropriate battery sizes for its buses. The Study calculates its replacement ratio based on the assumption that Arlington will choose a 440 kWh battery (a size first introduced in 2017) and rely on that battery size for all buses through 2038. Modeling such a small battery generates a high replacement ratio. Notably, Arlington has chosen to buy much larger battery sizes (588 kWh and 686 kWh) for its

[2] WMATA (Zero-Emission Bus Transition Plan, Final Report, March 2023 at p. 3). describes this approach succinctly:

> "Metro will first deploy battery-electric buses on the blocks that can be served by the current technology. To serve the few longer blocks, Metro will continue to assign its existing conventional internal combustion engine fleet (diesel, hybrid and CNG) through the transition and, if battery range improves sufficiently over the next several years, later assign electric buses to those blocks. If range continues to be a challenge, Metro will consider hydrogen fuel cell electric buses (which have longer range), opportunity charging, or both. Metro will continue to revisit battery-electric bus modeling and performance results as the bus network changes and evolves, and as the organization gains real-world experience operating these buses."

own pilot buses. This illustrates the extent to which many assumptions made in the Study are flawed or out of date.

- The modeling assumes that all buses are operating at an end-of-life battery condition, missing 20 percent of capacity. In reality, only a small portion of the buses may have degraded batteries at any given time and ART will not need to deal with this issue for many years. The initial BEBs delivered to ART in 2025 will not reach end-of-life until about 2037. As they near end-of-life, buses can be assigned to less demanding routes with no impact on the replacement ratio.
- The Study also references a number of fleet management strategies using charge management software, such as optimal route block pairing and on-route and midday charging, that with experience will facilitate reliable performance as BEBs are integrated into the fleet. Not optimal and likely unnecessary, the Study also considered replacing batteries at midlife or including non-electric heaters, both of which would eliminate most if not all battery capacity challenges.

**Hydrogen Infrastructure is Less Mature and Fuel is Costly**

The Kimley Horn study is unduly optimistic about the potential for hydrogen-powered FCEBs. While the Study highlighted numerous transit authorities pursuing FCEBs, all are much larger than Arlington and operate long routes that exceed the range of current BEBs on the market. Nationally, BEB sales far exceed FCEBs. As of September 2022, 5,269 BEBs and 211 FCEBs were in service or on order.[3] Moreover, only a small fraction of hydrogen produced in the United States today is "green" hydrogen generated directly from dedicated or excess renewable energy capacity, and infrastructure for production and distribution is still nascent.

The Study acknowledges that FCEBs will cost more to purchase and operate than BEBs.

- At a 1:1 replacement ratio for both BEBs and FCEBs, purchasing BEBs would save about $25 million in vehicle costs alone over the course of the transition.[4] The total estimated cost for BEB purchases between 2028 and 2038 would be about $40 million (30 percent) less than for 1:1.6 ratio scenario in table 3 of Appendix D.
- Fuel costs are noted to be both uncertain and much higher than for electricity. Given the large amount of electricity required to produce green hydrogen through electrolysis and then turn it back into electricity through a fuel cell this difference is likely to persist even as the industry matures.
- Fueling infrastructure for FCEB would require substantial upfront costs, raising the risk of stranded assets if technology changes. Charging capacity, in contrast, can grow incrementally with expansion of the BEB fleet.

**Conclusion**

The Kimley-Horn report does not provide a sound basis for the County Board to reverse or delay its 2021 directive that "electric fleet purchases be made for buses purchased for the new [AOMF]

[3] CALSTART's Zeroing in on ZEBs (through September 2022)

[4] The $25 million in savings is a conservative estimate based on figures presented in Appendix D, Table 3, which provides the cost in constant 2023 dollars of FCEBs and BEBs. The Table shows the cost of a BEB to be approximately $300,000 less than a FCEB.

facility." C2E2 urges the County Board to hold the County to that directive. It is time to begin the long transition away from methane-fueled buses with BEBs, deferring any pilots for FCEBs until the technology and infrastructure has improved and only if BEBs are unable to meet ART's needs.

We recognize the complex nature of managing a transit system and appreciate that shifting to a new technology will present challenges. But as we close in on the end of the hottest year on record, the cost of delay is far greater.

Sincerely,

Joan McIntyre

Chair, Climate Change, Energy and Environment Commission

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Mark Schwartz, County Manager
Michelle Cowan, Deputy County Manager
Greg Emanuel, Director, Department of Environmental Services
Mike Moon, Chief Operating Officer, Department of Environmental Services
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