

# A VISION FOR CLIMATE LEADERSHIP IN WASHINGTON, DC

Seizing the Economic, Climate, and Public Health Benefits of  
Electrifying WMATA's Transit Bus Fleet



OCTOBER 2020



# PARTNERS



# ACRONYMS

|                 |  |
|-----------------|--|
| CNG             | Compressed natural gas                         |
| CO <sub>2</sub> | Carbon dioxide                                 |
| EPA             | Environmental Protection Agency                |
| GHG             | Greenhouse gas emissions                       |
| IPCC            | Intergovernmental Panel on Climate Change      |
| PM              | Particulate matter                             |
| WMATA           | Washington Metropolitan Area Transit Authority |

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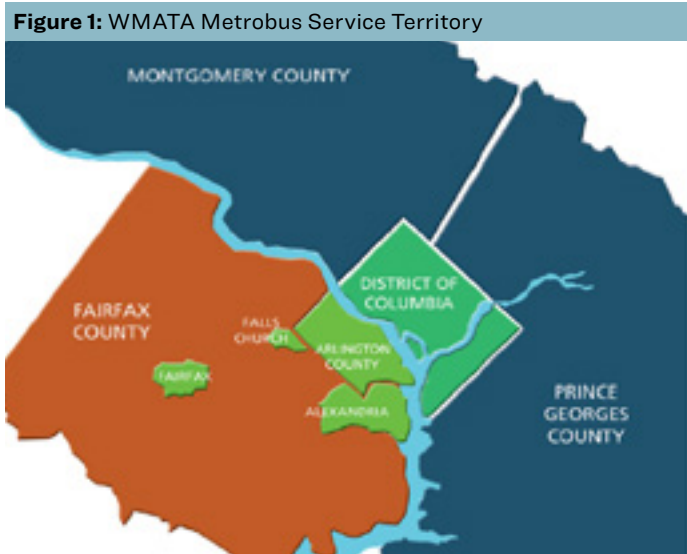
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# EXECUTIVE SUMMARY

The Washington Metropolitan Area Transit Authority (WMATA) operates the sixth-largest bus fleet in the United States, providing service to residents in Washington, Maryland, and Virginia,<sup>1</sup> with more than 130 million passenger trips per year.<sup>2</sup> By the fall of 2019, there were 528 fully electric buses in service in the US — a 29 percent increase from 2018.<sup>3</sup> WMATA currently has one electric bus and a plan to test up to 14 more starting in 2021.

In this rapidly evolving landscape, WMATA has not kept pace with other major US cities such as New York, Chicago, and Seattle, all of which have committed to fully electrify their public transit bus fleets by 2040 or before. Moreover, the 2018 Washington DC Climate and Energy Action Plan and the Clean Energy DC Omnibus Amendments Act (Clean Energy DC Act), signed in January of 2019, call for drastic reductions in climate pollution across numerous Washington, DC, sectors including public transit fleets. WMATA, however, is still operating under a 2017 Fleet Management Plan that provides a 10-year roadmap for WMATA’s bus fleet

through 2030.<sup>4</sup> But that fleet plan calls for WMATA to purchase 100 new diesel or compressed natural gas (CNG) buses per year through 2025<sup>5</sup> and is now badly out-of-step with the 2018 Climate and Energy Action Plan and the 2019 Clean Energy DC Act.



Source: WMATA, Fleet Management Plan at 1.

**Figure 2: Transit Electrification Commitments Across US**

| CITY          | ELECTRIFICATION COMMITMENT <sup>6</sup> |
|---------------|---|
| Los Angeles   | 2030                                    |
| Santa Barbara | 2030                                    |
| Santa Monica  | 2030                                    |
| San Francisco | 2035                                    |
| Chicago       | 2040                                    |
| New York City | 2040                                    |
| Portland      | 2040                                    |
| Seattle       | 2040                                    |

Thankfully, WMATA finally appears poised to begin work on fleet electrification by updating its fleet management plan in 2020 and initiating an electric bus pilot program in 2021, which will include a two-year pilot study, with up to 14 electric buses, housed in up to three garages, with bus delivery expected in 2021.<sup>7</sup> Earlier this year, the Federal Transit Administration awarded WMATA \$4.1 million to purchase electric buses and related charging infrastructure.<sup>8</sup>

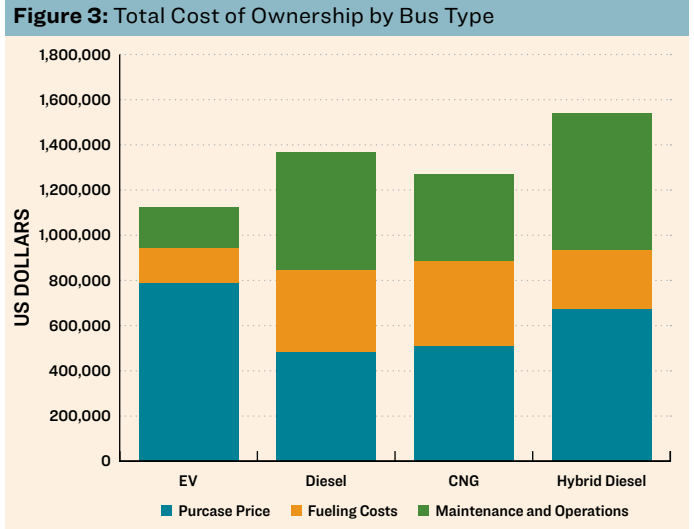
While these are important first steps, bold action is needed. Our organizations call on WMATA and its board of directors to publicly commit, as part of its updated fleet management plan, to electrify 100 percent of the

Metrobus fleet on a clearly defined timeline and to put sideboards on the electric bus pilot in order to ensure that the agency moves forward in an efficient manner without unnecessary delays. This report examines WMATA’s opportunity for climate and public health leadership given the size of its fleet, the clear call to action from the Washington DC Council, and the visibility afforded by its location in the nation’s capital and surrounding areas.

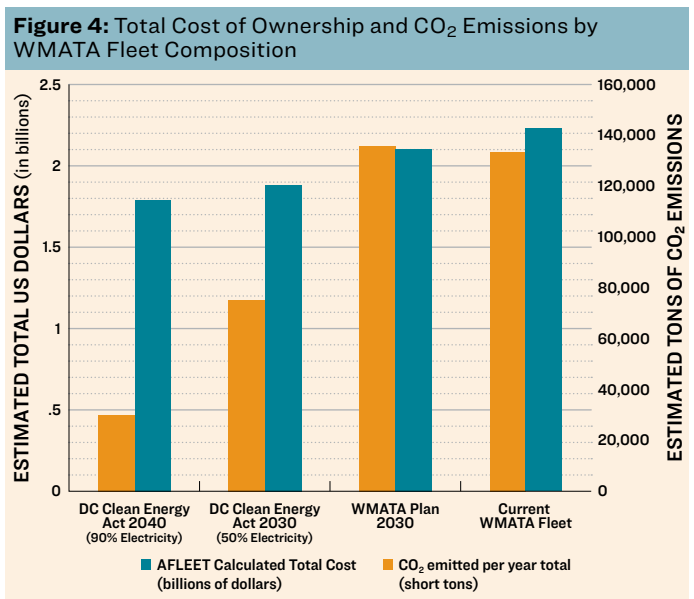
As shown in Figures 3 and 4, below, and discussed more fully in Sections II and III, electrification of WMATA’s bus fleet will lead to substantial cost savings for WMATA and corresponding reductions in climate pollution that benefit the public. As detailed in Section IV, electric buses dramatically reduce particulate matter and NO<sub>x</sub> emissions, and thus reduce healthcare costs to DC area residents. For each category of benefits — economic, climate, public health — the faster and more robust the electrification, the greater the benefits to WMATA, Washington DC area residents, and the planet.

Electrifying WMATA’s bus fleet in line with Clean Energy DC Act timelines would:

- Save WMATA at least \$350 million over the lifetime of the fleet at 50 percent electric buses, with those savings increasing with increasing electrification;
- Reduce greenhouse gas (GHG) emissions by more than 58,000 tons of carbon dioxide (CO<sub>2</sub>) per year by 2030 when 50 percent of the fleet is electrified under the Clean Energy DC Act, with reductions increasing as the fleet electrifies and the electric grid incorporates more clean energy;<sup>9</sup> and
- Improve air quality and public health for Washington DC area residents served by WMATA’s fleet, saving those residents more than \$8 million per year in healthcare costs once the fleet is fully electrified.
- Provide opportunities for current bus drivers and fleet maintenance staff to update their skills to operate and maintain the growing electric bus fleet, while providing new training opportunities and greener jobs for workers from disadvantaged communities, thereby adding to the region’s economic base. Through electrification, WMATA has the opportunity to help protect the health and economic interests of the people in the communities it serves while promoting the long-term economic viability of the WMATA bus system.



Source: Argonne National Laboratory’s Model.



Source: Argonne National Laboratory’s Model.

In Figure 4, above, note that WMATA’s 2017 Fleet Management Plan, which, until it is updated later this year, provides the most recent publicly-available WMATA roadmap for the future of WMATA’s fleet composition, would actually increase CO<sub>2</sub> emissions compared with its existing fleet by replacing diesel hybrid buses until the fleet is composed primarily of diesel and CNG buses. (See Figure 5, below.)

Our organizations call on WMATA to **publicly commit to electrify its 1,500-plus fleet of transit buses at least as quickly as the timeline set out in the Clean Energy DC Act — and ideally sooner.** To achieve this timeline, our organizations call on WMATA to take the following steps to implement the requirements of the Washington DC Climate and Energy Action Plan and the Clean Energy DC Act:



**a. Publicly commit to electrifying its fleet along the lines of the Clean Energy DC Act’s timeline for public buses:**

|                       |                       |                       |                        |
|-----------------------|-----------------------|-----------------------|------------------------|
| 2030:<br>50% electric | 2035:<br>75% electric | 2040:<br>90% electric | 2045:<br>100% electric |
|-----------------------|-----------------------|-----------------------|------------------------|

Transit agencies in large cities and smaller municipalities across the country are committing to fully electrify their buses. With the recent commitments to 100% electrification in public transit buses by California, Seattle, and New York, 33% of all transit buses in the US are committed to go electric by 2045.<sup>10</sup>

**b. Publicly release a transit bus electrification plan by the end Q1 2021.** As WMATA begins its work on electrification, it must replace the outdated 2017 fleet management plan. WMATA’s revised fleet plan should identify a pathway to meet the Clean Energy DC Act’s electrification timeline, including interim steps, necessary interjurisdictional coordination, timeframes for increasing electric bus purchases, and facilities upgrades. As part of that plan, WMATA should commit to releasing an **annual progress report** identifying milestones, challenges, and ongoing actions that facilitate rapid electrification.

**c. Immediately begin phasing out the purchase of internal combustion buses and commit to purchase only electric buses beginning no later than January 1, 2025.** WMATA’s buses have a 15-year lifespan, and WMATA should take immediate steps to cancel or amend any existing purchase agreements in order to convert prospective purchases of new diesel or CNG

buses to electric buses. In some instances, this may require additional service to extend the useful life of buses before retirement, but doing so would minimize the risk of stranded assets should WMATA purchase diesel buses now, only to have to retire those buses earlier than planned to meet electrification goals. WMATA’s current fleet is composed overwhelmingly of buses from New Flyer, which is also one of the nation’s leading manufacturers of electric buses.

**d. Immediately accelerate electric bus purchases as soon as feasible, but not later than 2021.** WMATA’s Zero Emissions Bus Update (Feb. 2020) indicates its upcoming pilot likely won’t take delivery of the first of its 14 buses until 2021. If WMATA has any realistic hope of achieving a 50 percent electric fleet (approximately 750 buses) by 2030, it must immediately ramp up purchases of electric buses.

**e. Prioritize the deployment of electric buses in low- and moderate-income neighborhoods and environmental justice communities** to ensure the benefits of electrification quickly reach those most impacted by soot and other transportation-related air pollution. WMATA should engage these communities in the electric bus planning effort now in order to address residents’ concerns, communicate the benefits of electrification, and ensure a smooth transition to electric bus service.

WMATA’s plans for an equitable and sustainable electric bus future can and should be accomplished without raising fares for the riders who depend on WMATA every day.



PHOTO: ISTOCK/ SCHARFSINN86

**f. Create an internal team** that reports directly to executive leadership, is empowered to oversee the electrification of the WMATA fleet, and will be accountable for meeting electrification benchmarks along specified timelines, for convening task forces or other stakeholder groups, and for updating electrification plans as needed. It is critical that WMATA dedicate a team that is both empowered to act on a wide range of matters and accountable for achieving defined goals. Among other things, at the outset of the electrification planning process WMATA must identify available funding streams (both from WMATA jurisdictions and at the federal level) to fund, and help offset, the up-front purchase price premium on electric buses.

**g. Create a multi-agency task force to engage in regional and utility planning across jurisdictions.** Effective planning across three jurisdictions will require collaboration with utilities, utility commissions, elected officials, state agencies, and community organizations in DC, Virginia, and Maryland. WMATA should create a multiagency task force to coordinate its planning throughout its service territories. It will be important to engage utilities early in this process to ensure adequate charging capacity and that rate structures are in place to facilitate the introduction of electric buses without the burden of demand charges or other avoidable economic barriers. The task force can help ensure WMATA prioritizes use of electricity from clean, renewable resources and incorporates technologies and rate designs that effectively manage increased electric load from electric bus charging in ways that maximize grid and economic benefits.

**h. Collaborate with transit agencies that are electrifying their bus fleets**, such as those in large cities like New York City, Los Angeles, Chicago, San Francisco, Seattle, and Miami-Dade, as well as smaller transit agencies in the Metro Area that are already operating electric buses or have had success procuring electric buses, such as those in Alexandria (DASH), Montgomery County (RideOn), Prince George’s County (TheBus), and DDOT in DC (DC Circulator), to share lessons learned and best practices.

**i. Ensure that any significant upgrades to bus garages or fueling infrastructure include “EV ready” designs beginning immediately.** Planning for appropriate facilities upgrades will be a critical part of the planning process, as WMATA will need to invest in both bus garage and on-road charging infrastructure. Any major upgrades to bus garages going forward should be completed with an eye toward full electrification of WMATA’s fleet. WMATA has already planned to rebuild the 14th Street and Bladensburg bus garages as electric-bus ready, with charging stations for 288 buses at Bladensburg alone.<sup>11</sup> WMATA should also build on its July 2020 announcement that it would partner with SunCommon to install solar canopies at four Metro train depots at no cost to the agency.<sup>12</sup>

Scientists have made it clear that we must dramatically reduce GHG emissions over the next decade if we hope to avoid the direst effects of climate disruption, and the public health impacts of diesel emissions are well-documented. Now is the time for WMATA to truly live up to the promise of its “Back to Good” campaign and deliver Washington DC area residents the benefits of electrification.



PHOTO: ISTOCK/ SCHARFSINN86

# 1. INTRODUCTION

## A. WMATA'S FLEET

With a fleet of more than 1,500 buses,<sup>13</sup> WMATA operates the sixth-largest transit bus fleet in the United States,<sup>14</sup> and it now has the opportunity to lead the nation in mass transit electrification at a scale and on a timeline that match Washington DC's ambitious Clean Energy DC Plan and the 2019 Clean Energy DC Act. Finalized in 2018, the plan calls for steep reductions in GHG emissions from the transportation and electric sectors and explicitly recognizes the importance of local action in meeting the Paris Agreement's climate goals.<sup>15</sup> In January 2019, Washington DC mayor Muriel Browser signed the Clean Energy DC Act — establishing an ambitious suite of climate policies that require Washington DC to get 100 percent of its electricity from renewable resources by 2032, strengthen energy

efficiency standards for new buildings, and fully electrify public transit and private fleets by 2045.<sup>16</sup>

WMATA's current fleet is composed of 1,571 buses, predominantly hybrid diesel and CNG buses, which make up 52 percent and 29 percent of the total fleet, respectively. However, WMATA's 2017 Fleet Management Plan actually lays out a path backwards and entails purchasing approximately 100 internal combustion buses per year between 2020 and 2025.<sup>17</sup> The passage of the Clean Energy DC Act has shifted the landscape since WMATA released its 2017 Fleet Management Plan. And although WMATA's December 2019 Bus Transformation Action Plan mentioned electric buses, and its February 2020 Zero-Emission Bus Update announced a two-year pilot for electric buses with delivery expected in 2021, WMATA has not made any public commitment to fully electrify WMATA's fleet.



PHOTO: ISTOCK/ JOE\_POTATO



## B. CLEAN ENERGY DC ACT TIMELINES AND WMATA BUS PURCHASING

WMATA's revised fleet-planning process offers WMATA the ideal opportunity to publicly commit to meeting or exceeding the Clean Energy DC Act's timelines by electrifying its fleet to at least 50 percent by 2030, 75 percent in 2035, 90 percent in 2040, and 100 percent in 2045.<sup>18</sup> As part of that planning process, WMATA should define concrete next steps to ensure effective and efficient implementation of lessons learned through the upcoming two-year pilot.

The Clean Energy DC Act's timeline presents an aggressive, but achievable, 25-year path toward full fleet electrification. And while those targets are certainly realistic, WMATA must immediately begin increasing EV purchases now to have any realistic hope of meeting those targets. The average lifespan of WMATA's buses is approximately 15 years.<sup>19</sup> At the current rate of 100 new bus purchases per year, and with a fleet of more than 1,500 buses, WMATA could, in theory, meet the 2045 timeline for full electrification by purchasing only electric buses beginning in 2030. However, to meet the 2030 target of a 50 percent electric fleet, or the 2035 target of 75 percent electric, WMATA would need to begin purchasing 100 electric buses per year in approximately 2023. Achieving such a steep curve appears unlikely, given that WMATA does not plan to start its two-year, 14-bus pilot until 2021 at the earliest. However, the near-term steps outlined in this report, if adopted, would set WMATA on a path to meet both the long-term goals and most of the interim benchmarks in the Clean Energy DC Act.

As part of its short-term planning, WMATA needs to amend any purchase contracts for diesel or CNG buses and convert those to electric bus orders. Doing so will help avoid stranded assets caused by having to retire diesel or CNG buses before the end of their useful life in future years in order to meet electrification goals. Although delaying purchases may require extending maintenance and service plans for some buses, it would avoid locking in emissions from upwards of 500 new diesel or CNG buses between now and 2025, each of which would run for approximately 15 years. Moreover, the vast majority of WMATA's buses are made by New Flyer,<sup>20</sup> which also offers electric buses in 30-, 40-, and 60-foot models. New Flyer estimates that its gas-powered buses start around a purchase price of \$450,000, while their electric versions start at around \$700,000, and that over the lifetime of the buses each electric bus saves approximately \$400,000 in fuel costs and \$125,000 on maintenance.<sup>21</sup>

## C. REPORT FINDINGS

Incorporating WMATA-specific data on the types of buses in its fleet, vehicle miles traveled, and electricity and fuel costs, and then using that data in national modeling tools, this report arrives at three principal conclusions:

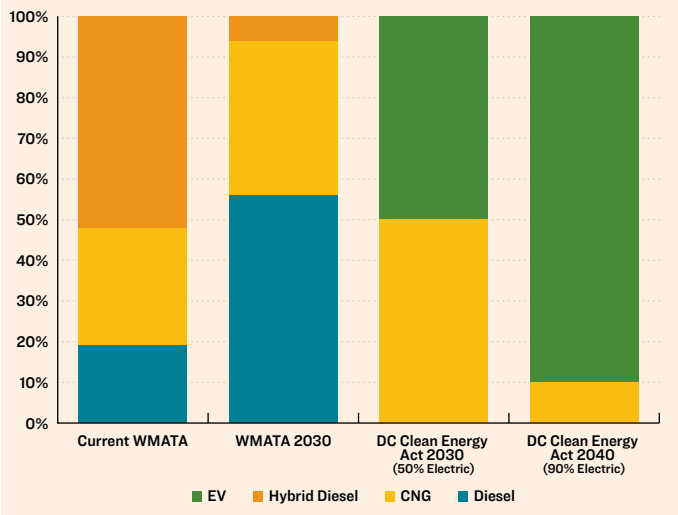
First, converting to electric buses would result in substantial cost savings through reduced fuel and maintenance costs, which would more than make up for the current up-front premium on the purchase price of electric buses compared with diesel and other types of transit buses. Utilizing the AFLEET model created by Argonne National Lab in 2017, and conservative cost assumptions, this report compares the total cost of ownership of different bus types, factoring in purchase price, fuel, and operation and maintenance costs.

Second, converting to electric buses would lead to significant annual GHG emissions reductions across the fleet scenarios, and these reductions grow larger over time as more of the fleet shifts to electric buses. To estimate net emissions reductions, this report's analysis of GHG emissions incorporates both on-road emissions from the buses themselves as well as emissions from the electric grid based on the necessary charging of electric buses in the future. This analysis incorporates applicable renewable portfolio standards for Washington DC and Maryland; and, for remaining grid emissions in all three WMATA service areas, utilizes conservative assumptions based on emissions from an average combined cycle gas plant.

Third, converting from diesel and CNG to electric buses would lead to tremendous public health benefits for Washington DC area residents in WMATA's service territory based on reduced air pollution. To quantify these benefits, this report utilizes the US EPA's Diesel Emissions Quantifier model, which uses specified indicators, such as reductions in emergency room visits, hospitalizations, and days off work, to estimate avoided healthcare costs as a result of reduced particulate matter and NO<sub>x</sub> emissions. Our organizations recognize that the global pandemic has put a strain on the health and financial well-being of people and communities across the country, and that transit agencies have seen dramatically reduced ridership as a result. WMATA should use any financial assistance that becomes available as part of a federal economic stimulus plan to invest in a clean and sustainable transit bus system for the future rather than further tying WMATA to fossil-fueled buses. This report provides a vision for the future of WMATA's transit bus system that is fully electric and also provides a net positive financial return to the agency. These aims can be

accomplished without sacrificing core principles of economic equity and environmental justice. Were WMATA to follow these recommendations, it would reduce local and global pollution while investing in the people and communities it serves by prioritizing the electrification of bus routes through disadvantaged communities and by creating job retraining and employment opportunities for current WMATA drivers and maintenance workers and people in disadvantaged communities.

**Figure 5:** Composition of Current and Potential WMATA Fleets, by Fuel Type



Source: WMATA Fleet Management Plan (2017)<sup>22</sup>

Transportation accounts for the largest portion of US GHG emissions (29 percent) of any sector of our economy nationally,<sup>23</sup> and for approximately 41 percent of GHG emissions in the DC metro area.<sup>24</sup> Seated in the nation’s capital, with a massive bus fleet and supportive local government, WMATA is ideally situated to lead the transformation of mass transit bus fleets toward full electrification on an aggressive timeline.

Our organizations call on WMATA to show real economic, climate, and public health leadership by committing to electrify its fleet at least at least as quickly as mandated by the DC Clean Energy DC Act — and ideally sooner. Doing so would save WMATA hundreds of millions of dollars in operating expenses, reduce GHG emissions and associated climate harms felt across the globe, and make the air cleaner to breathe for DC area residents.

## 2. COST SAVINGS FROM WMATA BUS FLEET ELECTRIFICATION

### A. PER-BUS COST SAVINGS

To study the economic effects of transit bus electrification, this report uses the Argonne National Laboratory’s Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool, which utilizes purchase price and annual operating costs, along with other data, to compare costs from electric buses with conventional-fuel counterparts.<sup>25</sup> Where possible, we utilized WMATA-specific data based on its fleet, vehicle miles traveled, and other inputs. The results of this AFLEET analysis demonstrate that electrification of WMATA’s bus fleet would bring substantial economic savings due to the lower total cost of ownership per bus when compared with diesel, hybrid diesel, and CNG buses.<sup>26</sup>

Figures 6 and 7, below, display the total lifetime cost of ownership for electric, diesel, CNG, and hybrid buses,

as well as projected per-bus savings when switching to electric buses as modeled by AFLEET.

**Figure 6:** Breakdown of Lifetime Cost of Ownership Per Bus by Fuel Type

|   | Electric    | Diesel      | CNG         | Hybrid      |
|---|-------------|-------------|-------------|-------------|
| <b>Purchase Price</b>                   | \$789,000   | \$485,155   | \$509,756   | \$673,693   |
| <b>Fueling Costs</b>                    | \$154,799   | \$359,876   | \$373,909   | \$261,077   |
| <b>Maintenance &amp; Operations</b>     | \$181,090   | \$522,894   | \$387,761   | \$603,909   |
| <b>Total Lifetime Cost of Ownership</b> | \$1,124,899 | \$1,365,925 | \$1,271,426 | \$1,538,679 |

Source: Argonne National Laboratory’s AFLEET Model (2017)

**Figure 7: Lifetime Cost of Ownership Per Bus by Fuel Type and Cost Savings from Electrification**

|  | Electric    | Diesel      | CNG         | Hybrid      |
|--|-------------|-------------|-------------|-------------|
| <b>Total Lifetime Cost of Ownership</b>                                    | \$1,124,899 | \$1,365,925 | \$1,271,426 | \$1,538,679 |
| <b>Lifetime savings of an electric bus over diesel, CNG bus and hybrid</b> | –           | \$241,026   | \$146,527   | \$413,780   |
| <b>Percentage savings of electric bus over diesel, CNG and hybrid</b>      | –           | 21%         | 13%         | 37%         |

Source: Argonne National Laboratory's AFLEET Model (2017)

## B. FLEET-WIDE COST SAVINGS

The per-unit savings on electric buses compared with all other fuel types has the potential to save WMATA hundreds of millions of dollars when translated to electrification across WMATA's entire fleet of 1,571 buses.<sup>27</sup> The faster WMATA transitions to electric buses, the greater the fleet-wide economic benefit that WMATA would realize as annual savings on fuel, operation and maintenance grow year over year.

As showed in Figure 8, below, electrification of WMATA's fleet along Clean Energy DC Act timelines for 2030 and 2040 would result in significant fleet-wide cost savings for WMATA, which would increase as further electrification yields greater annual savings on fuel, operation, and maintenance costs.<sup>28</sup> Again, these calculations are highly conservative — for example, they

do not incorporate the proven track record of plummeting battery costs over time.

**Figure 8: AFLEET Total Cost of Ownership Across Fleet Scenarios**

| Fleet Plan                          | AFLEET Calculated Total Cost (dollars) | Percent Savings Compared With Current WMATA Fleet | Dollars Saved Compared With Current WMATA Fleet |
|-------------------------------------|--|---|---|
| <b>Current WMATA Fleet</b>          | \$2,234,365,885                        | –   | –   |
| <b>WMATA Plan 2030</b>              | \$2,104,441,407                        | 6%  | \$129,924,478                                   |
| <b>CEDC Act 2030 (50% electric)</b> | \$1,882,240,024                        | 16%   | \$352,125,861                                   |
| <b>CEDC Act 2040 (90% electric)</b> | \$1,790,221,068                        | 20%   | \$444,144,817                                   |

Source: Argonne National Laboratory's AFLEET Model (2017)

As depicted in Figure 8, above, our AFLEET modeling shows that electrifying 50 percent of WMATA's fleet by 2030, as directed by the Clean Energy DC Act, would save WMATA more than \$350 million on lifetime costs compared with the total cost of ownership of WMATA's current fleet.<sup>29</sup> By 2040, with 90 percent of the fleet electric under the Clean Energy DC Act's framework, those fleet-wide savings increase to more than \$440 million. WMATA's 2017 Fleet Management Plan, by contrast, which calls for replacing hybrid diesel buses with diesel buses by 2030,<sup>30</sup> would generate far smaller cost savings compared with the current fleet composition.



PHOTO: ISTOCK/ SEMEN SALIVANCHUK

### 3. GHG REDUCTIONS FROM WMATA BUS FLEET ELECTRIFICATION

#### A. THE CLIMATE CRISIS AND SUMMARY OF GHG REDUCTIONS ACHIEVABLE

We are in a global climate crisis. In 2018, the Intergovernmental Panel on Climate Change (IPCC) concluded that anthropogenic CO<sub>2</sub> emissions must substantially decline by 2030 in order to keep average global temperatures within 1.5°C of pre-industrial times.<sup>31</sup> The IPCC also found that the global economy must reach net-zero emissions around 2050 to avoid the most dire effects of climate change.<sup>32</sup>

Despite scientific consensus and stark real-world reminders, our policies do not yet match the urgency of the climate crisis. July 2019 was the hottest month ever recorded.<sup>33</sup> In September 2019, devastating floods in Houston marked the third 500-year rain event in Texas in the past three years.<sup>34</sup> In the summer and fall of 2020, catastrophic wildfires burned more than 5 million acres across the western U.S., forcing mass evacuations across California and Oregon.<sup>35</sup> And in November 2019, the United Nations released a report on the global GHG “emissions gap”— essentially a comparison of “where we are” versus “where we need to be”— concluding that by 2030 global GHG emissions must be 55 percent lower than 2018 in order to limit warming to 1.5°C.<sup>36</sup>

To meet these climate objectives, immediate action must be taken at every level of government and in all sectors of our economy. Cities and transit agencies across the US, including in New York,<sup>37</sup> Los Angeles,<sup>38</sup> San Francisco,<sup>39</sup> and Chicago,<sup>40</sup> have already made commitments to go fully electric and have taken concrete steps toward purchasing electric buses and electrifying their public transit bus fleets. For example, in April 2019 Chicago committed to convert its transit fleet to 100 percent electric buses by 2040.<sup>41</sup> In November 2019, Los Angeles announced the purchase of 130 electric buses as part of its plan to fully electrify its transit fleet by 2030.<sup>42</sup> And in December 2019, New York City deployed the first 15 of the 500 electric buses it plans to put into service over the next five years.<sup>43</sup> Locally, in Alexandria, Virginia, DASH has already taken concrete steps toward electrifying its fleet and expects to have the necessary charging infrastructure in place this year for the first of its electric fleet.<sup>44</sup> Initiating purchases at scale as quickly as possible would best serve WMATA and DC area residents, providing real-time experience with the buses for WMATA, as well as immediate benefits for transit riders and allowing for a smoother transition to an electrified fleet.

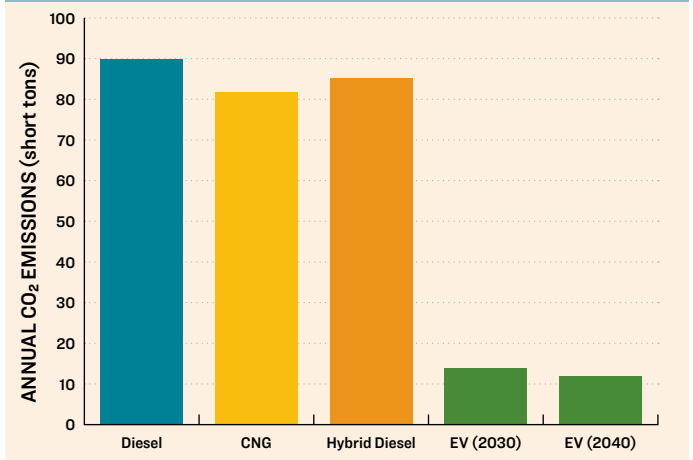
As explained in detail below, the analysis in this report demonstrates that electrifying WMATA’s bus fleet along the timelines set out by the Clean Energy DC Act would reduce fleet-wide CO<sub>2</sub> emissions from WMATA’s buses by approximately 44 percent in 2030 and approximately 78 percent in 2040.

#### B. GHG EMISSIONS REDUCTIONS PER BUS

Similar to the economic analysis, electrification of WMATA’s transit bus fleet also offers substantial reductions in GHG emissions. This report incorporates projections for both on-road and electric grid emissions for electric bus charging, with grid emissions decreasing over time as Maryland and Washington DC incorporate more clean energy into their electricity mix.<sup>45</sup>

Compared with every other bus fuel type, electric buses

**Figure 9: WMATA Annual CO<sub>2</sub> Emissions per Bus by Type**



are significantly cleaner in terms of CO<sub>2</sub> emissions, even factoring grid emissions from charging electric batteries. While hybrid diesel and CNG buses emit marginally less CO<sub>2</sub> than diesel, they emit far more CO<sub>2</sub> than electric buses. (See Figure 9, above.) Per-bus emissions displayed above for electric buses differ in 2030 and 2040 primarily due to improving renewable portfolio standards in DC and Maryland.

#### C. FLEET-WIDE GHG EMISSIONS REDUCTIONS

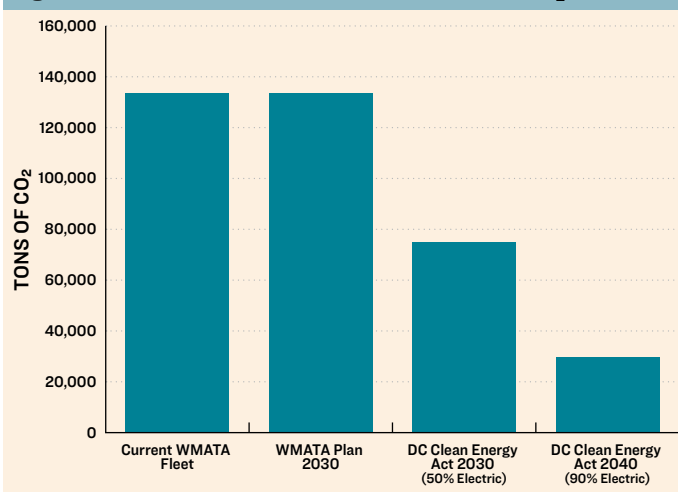
To compare fleet-wide GHG emissions scenarios, we took the per-bus calculations from above, and multiplied those figures across fleet compositions. The significant



differences in per-bus emissions rates based on fuel type, combined with WMATA's fleet size, present WMATA with the opportunity to substantially reduce CO<sub>2</sub> emissions across its transit bus fleet. Figure 10 shows the estimated annual fleet-wide CO<sub>2</sub> emissions across fleet scenarios, while Figure 11 additionally displays percentage of CO<sub>2</sub> saved compared with WMATA's current fleet. Remarkably, WMATA's 2017 Plan would lead to an *increase* in CO<sub>2</sub> emissions compared with its current fleet. In contrast, the Clean Energy DC Act 2030 scenario, which would entail half of the bus fleet being electric in 2030, would generate a 44 percent reduction in annual CO<sub>2</sub> emissions compared with the current fleet.

The Clean Energy DC Act's 2030 and 2040 electrification scenarios yield drastic reductions in CO<sub>2</sub> emissions compared with WMATA's current fleet, resulting in annual emissions savings of 44 percent and 78 percent, respectively. These potential savings thus offer WMATA the opportunity to demonstrate strong

**Figure 10: Annual WMATA Estimated Fleet-wide CO<sub>2</sub> Emissions**



**Figure 11: Annual Fleet-wide CO<sub>2</sub> Emissions and Percentage Savings Compared With Current WMATA Fleet**

|                              | CO <sub>2</sub> Emitted per Year (Short Tons) | Percentage of CO <sub>2</sub> Emissions Reductions Compared With Current WMATA Fleet |
|------------------------------|---|--|
| Current WMATA Fleet          | 133,549                                       | 0%   |
| WMATA Plan 2030              | 135,799                                       | -2%  |
| CEDC Act 2030 (50% electric) | 74,982  | 44%  |
| CEDC Act 2040 (90% electric) | 29,788  | 78%  |

climate leadership while saving hundreds of millions of dollars in the process.

#### D. AVOIDED SOCIAL COSTS

The social cost of carbon, developed by an Interagency Working Group composed of experts from more than a dozen federal agencies and offices, provides an estimate of the global economic damage, in dollars, caused by each incremental ton of CO<sub>2</sub> emitted into the atmosphere.<sup>46</sup> The tool estimates impacts such as drought, wildfires, decreased agricultural productivity, and sea level rise, among others. Although there is significant variation in the social cost figures depending on the discount rate used, using a discount rate of 3 percent, the social cost of each incremental ton of CO<sub>2</sub> emitted into the atmosphere in 2030 is \$50. Electrifying WMATA's fleet along the Clean Energy DC Act's timeline would save more than 58,000 tons of CO<sub>2</sub> per year by 2030 (see Figure 11 above) and avoid at least \$2.9 million annually in global economic damages — annual savings that would increase as the social cost of each ton of CO<sub>2</sub> emitted into the atmosphere rises in successive years and WMATA electrifies more of its fleet.



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## 4. PUBLIC HEALTH SAVINGS OF WMATA BUS FLEET ELECTRIFICATION

The electrification of WMATA's bus fleet would also significantly improve the air quality for people who live and work in WMATA's service territory, which spans Washington DC and parts of Maryland and Virginia. Reducing emissions of particulate matter, NO<sub>x</sub>, and other pollutants from transit buses would not only improve air quality — particularly important for public health given that the Washington DC area is in nonattainment for the health-based National Ambient Air Quality Standards (often referred to as NAAQS) for ground level ozone — but also would have quantifiable benefits in healthcare cost savings by reducing the incidence of asthma and other respiratory ailments, emergency room visits, hospital stays, and days off work.<sup>47</sup> Using the US EPA's publicly available Diesel Emissions Quantifier tool, which estimates reduced healthcare costs associated with changes in particulate matter emissions, we calculate that electrifying WMATA's bus fleet would save area residents more than \$8 million per year in reduced healthcare costs.

### A. PUBLIC HEALTH IMPACTS

Motor vehicles contribute significantly to air pollution; for example, the EPA estimates that the transportation sector was responsible for over 163 million tons of particulate matter (PM<sub>2.5</sub>) emissions in 2014.<sup>48</sup>

Particulate matter can harm the respiratory system, and those exposed may experience symptoms ranging from trouble breathing and cough to critical, life-threatening developments such as decreased lung function and cardiovascular disease.<sup>49</sup> Even relatively low levels of exposure can harm vulnerable populations such as children, people aged 65 years or older, outdoor workers, and those with existing respiratory problems or cardiovascular disease.<sup>50</sup>

Children are especially affected by asthma: One in twelve children in the US has asthma, which was responsible for approximately 13.8 million missed days of school in 2013.<sup>51</sup> Children of color, specifically African American children, bear a double burden. The negative health effects of particulate matter disproportionately affect low-income populations, people of color, and vulnerable populations like children and the elderly.<sup>52</sup> In 2015, the US Department of Health and Human Services found that African American children were four times more likely to be hospitalized for asthma compared with white children.<sup>53</sup>

In Washington DC, over ten percent of children have asthma,<sup>54</sup> well above the national average of 8.4 percent.<sup>55</sup> Childhood asthma in DC disproportionately affects poor and urban minority children.<sup>56</sup> Wards 7 and 8, which compose the bulk of Southeast DC, are particularly affected. According to data from Children's National Hospital, children who live in Ward 8 have



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20 to 25 times the number of emergency room visits compared with children in Northwest neighborhoods, due in large part to asthma and other respiratory issues.<sup>57</sup>

A comprehensive electrification implementation plan for WMATA should prioritize electrifying bus routes that serve low- and moderate-income areas and environmental justice communities. This would help ensure that the benefits of transportation electrification are more equitably distributed to all Washington DC area residents by improving access to clean, electric transportation options for particularly vulnerable populations.

## B. HEALTHCARE COST SAVINGS FROM WMATA ELECTRIFICATION

Cities with poor air quality carry a heavy economic burden. This burden can be quantified using indicators of public health, such as bronchitis, increased incidence of asthma, upper and lower respiratory symptoms, hospital admissions, emergency room visits, and days lost from work.

The EPA’s Diesel Emissions Quantifier model, which is one available tool for such an analysis, uses these indicators, among others, to estimate an area’s annual avoided health costs as a result of reduced emissions.<sup>58</sup> The model, updated in July 2019,<sup>59</sup> calculates emissions for both baseline and replacement vehicles; in this case, WMATA’s baseline of hybrid, diesel, and CNG buses, and a hypothetical replacement fleet of all electric buses. The model has been used to make similar projections regarding the public health benefits of electrifying transit fleets in other cities, including Chicago and New York.<sup>60</sup> Chicago Transit Authority, for example, estimated that

its residents would save \$55,000 on avoided healthcare costs per year per electric bus; New York’s Metropolitan Transportation Authority estimated savings of \$150,000 per bus per year based on a reduction of approximately 97.5 percent in per bus particulate matter emissions.<sup>61</sup>

Were WMATA to electrify its bus fleet, the D.C. metro area would see a considerable drop in particulate matter and NO<sub>x</sub> emissions and, consequently, a drop in the negative health effects brought about by these emissions. Using the EPA’s model, we estimate the area served by WMATA would see \$8,210,000 in annual health cost savings as a result of converting WMATA’s fleet to 100 percent electric buses. The District would reap the greatest benefits in avoided health costs (over \$6 million each year) and the four Virginia and Maryland counties that WMATA also serves would each see hundreds of thousands of dollars in avoided health costs annually. While these projections are conservative and based on EPA’s publicly available model, regardless of which tool WMATA uses, we urge it to take avoided healthcare costs to area residents into consideration when undertaking any economic analysis of its fleet-management decisions.

**Figure 12: Annual Avoided Healthcare Costs by County**

| County               | Annual Savings        |
|----------------------|-----------------------|
| District of Columbia | \$6,740,000.00        |
| Prince George’s, MD  | \$601,000.00          |
| Montgomery, MD       | \$250,000.00          |
| Arlington, VA        | \$277,000.00          |
| Fairfax, VA          | \$351,000.00          |
| <b>Total</b>         | <b>\$8,210,000.00</b> |

Source: EPA Diesel Emissions Quantifier

## 5. SUMMARY AND RECOMMENDATIONS

WMATA should demonstrate strong climate leadership at the local level by committing to electrify its 1,500-plus bus fleet at least as quickly as set out in the Clean Energy DC Act signed into law in 2019. Electrifying WMATA’s fleet is a critical step toward meeting Washington DC’s climate goals and will help reduce the transportation sector’s GHG emissions, which is essential if we hope to keep global temperatures within a 1.5 degree-increase as called for by the international and scientific communities in the Paris Climate Accord. Electrifying the fleet along Clean Energy DC Act timelines would save WMATA hundreds of millions of dollars, reduce climate pollution by more than 58,000 tons of CO<sub>2</sub> per year by 2030 (and

more in later years) and would reduce the heavy toll that air pollution has on the area’s most vulnerable residents.

WMATA must take immediate steps toward electrification. This should start with a public commitment to convert its transit bus fleet to 100 percent electric buses as directed by the Clean Energy DC Act and include a public and transparent process to develop and release a plan for the long-term conversion of the fleet. In that plan, WMATA should examine how other transit agencies have minimized the up-front cost burden of purchasing electric buses instead of fossil-fueled alternatives. For example, Pay As You Save programs, utilizing on-bill tariffs for electric buses,



would allow municipalities and transit agencies to purchase more electric buses with the same amount of funding they would otherwise dedicate for transit bus purchases.<sup>62</sup> Additionally, the federal Lo-No Emission Vehicle Program provides funding to state and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses, including acquisition, construction, and leasing of required charging infrastructure.<sup>63</sup> Other options, including the use of municipal bonds, could also be considered.

Our organizations therefore call on WMATA to take the following steps to meet the mandate of the 2019 Clean Energy DC Act and electrify its fleet to provide a healthier, cleaner transportation system for all Washington DC area residents:

**1. WMATA should publicly commit to electrifying its bus fleet along or faster than the timelines provided in the Clean Energy DC Act, with at least 50 percent electric by 2030, 75 percent by 2035, 90 percent by 2040, and 100 percent by 2045.**

Numerous transit agencies in cities across the country have committed to fully electrify their public transit

fleets by dates ranging from 2030 to 2040. Examples include, among others, Santa Monica (2030),<sup>64</sup> Santa Barbara (2030),<sup>65</sup> Los Angeles (2030),<sup>66</sup> San Francisco (2035),<sup>67</sup> Seattle (2040),<sup>68</sup> New York City (2040),<sup>69</sup> Portland (2040),<sup>70</sup> and Chicago (2040).<sup>71</sup>

**2. WMATA should develop and publicly release a transit bus electrification plan by the end of the first quarter in 2021 and commit to preparing an annual progress report each year thereafter until full electrification is secured.**

Developing and releasing a comprehensive electrification plan in a public and transparent process will help WMATA engage the public as a partner in this long-term transition to an electric fleet over the next 25 years. Other cities have incorporated similar plans into their fleet electrification processes. For example, Chicago is currently developing its plan, scheduled for release in December 2020, to help it identify key strategies, milestones, and timelines for an equitable transition to an all electric fleet by 2040.<sup>72</sup> Similarly, New York City's transit authority developed a 2020-2024 capital plan allocating \$1.1



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billion toward the purchase of 500 electric buses during that timeframe.<sup>73</sup>

As part of that plan, WMATA should also review current, ongoing actions, including the modernization of its bus barns and the purchase of buses, and transparently explain how those actions are preparing for imminent electrification and the implementation of its bus electrification plan.

**3. WMATA should end the purchase of internal combustion buses no later than January 1, 2025, and ideally sooner** in order to maximize cost savings to WMATA and avoid locking in unnecessary carbon dioxide and diesel emissions that harm the planet and health of DC area residents. **In the meantime, WMATA should take all available steps to cease the purchase of internal combustion engine buses that are not necessary to continue operations.**

Given the 12-15 year lifespan of WMATA buses, **2025 must be the last date for fossil fuel bus purchases if WMATA is to efficiently meet a 2040 target of a minimum 90 percent electric bus fleet.** Postponing a phaseout of fossil fuel bus purchases beyond 2025 would unnecessarily delay the economic, climate, and public health benefits of electrification. Indeed, states and cities across the country have pledged to phase out such purchases well ahead of full transit electrification. Examples of pledges to stop purchasing fossil fuel buses include commitments from cities such as Seattle (by 2020),<sup>74</sup> San Francisco (by 2025),<sup>75</sup> and Los Angeles (by 2025), and less aggressive commitments by New Jersey (2032),<sup>76</sup> and California's state-wide commitment (2029).<sup>77</sup>

**4. WMATA should immediately accelerate electric bus purchases as soon as feasible, but no later than 2021.**

Numerous transit agencies are already taking delivery of significant numbers of electric buses in 2020 and 2021. For example, New York City's recently acquired bus fleet includes fifteen 60-foot articulated electric buses, which began deploying on one of the city's busiest routes along 14th Street in December 2019.<sup>78</sup> In 2018, Chicago ordered 20 electric buses for its fleet,<sup>79</sup> and in November 2019, Miami announced the purchase of 33 electric buses.<sup>80</sup> Los Angeles, which purchased an additional 130 electric buses in November 2019,<sup>81</sup> announced it will have 40 sixty-foot articulated buses operating by the fall of 2020 and will completely electrify its silver bus line in 2021.<sup>82</sup> Even Washington DC's own Circulator has had 14 electric buses in service since 2018.<sup>83</sup>

**5. WMATA should prioritize deployment of electric buses in low- and moderate-income neighborhoods and environmental justice communities, and ensure hiring and job retraining opportunities for those from disadvantaged areas.**

WMATA should engage low- and moderate-income communities in the planning process and prioritize electrifying routes through those neighborhoods in order to reduce transportation-related pollution in areas most impacted, improve public health, and ensure that the benefits of electrification are most equitably distributed throughout WMATA's service territory. As part of the transition to an electric bus fleet, WMATA should also ensure that current drivers and maintenance specialists have adequate job-retraining opportunities to work on the newly electrified fleet, and that those opportunities also reach people from nearby disadvantaged areas to ensure that the communities served by WMATA share in some of the economic benefits of bus electrification.

**6. WMATA should create an internal task force that reports directly to executive leadership and that is empowered to oversee the electrification of the WMATA fleet.**

WMATA needs a team that is empowered to overcome bureaucratic obstacles, drive forward electrification, and be accountable directly to WMATA's leadership. It is also important to establish clear accountability for meeting both near-term benchmarks and long-term targets that extend 25 years into the future.

**7. WMATA should create jurisdiction-specific, multiagency and utility task forces to draw upon the authorities needed to electrify rapidly, including utilities that operate in each jurisdiction, and the Public Service Commissions in DC and Maryland and the State Corporation Commission in Virginia.**

WMATA should begin outreach to external stakeholders to ensure its electrification plans are implemented as smoothly as possible and that WMATA has the benefit of insights on best strategies and practices from the relevant Public Service Commissions, electric utilities, as well as the DC Council, the DC Mayor's Office, and public officials in Maryland and Virginia.<sup>84</sup> Such outreach would help WMATA assess available funding mechanisms, electric rate structures for charging, charging infrastructure needs, and the necessary regulatory approvals.

**8. WMATA should establish an ongoing collaboration with transit agencies in nearby areas and large public transit agencies across the country that already have electric buses in service.**

As noted throughout this report, states, cities, and transit agencies across the country are already moving forward on transit bus electrification, including those with large urban populations in northern climates. WMATA should gather data and endeavor to apply lessons learned from other cities at the outset of this process. Transit agencies in places with a similar climate and multijurisdictional territories may be particularly useful for WMATA to connect with in order to overcome hurdles experienced elsewhere. Additionally, at least four other transit agencies in nearby areas already have experience procuring and operating electric buses, including the DDOT Circulator in DC and agencies in Alexandria, Prince George’s County, and Montgomery

County. WMATA should engage these agencies to evaluate potential funding streams and effectively coordinate with utilities, bus and charging equipment providers, and community organizations.

**9. Ensure that any significant upgrades to bus garages or fueling infrastructure include “EV ready” designs.**

Once WMATA commits to full electrification, it should commence an immediate review of charging infrastructure needs and the feasibility and cost of upgrades at existing facilities, as it has already done for the 14th Street and Bladensburg garages. This should include analysis of both garage structures and any electrical infrastructure needs to accommodate large-scale bus charging in the future. As that review takes place, at a minimum, WMATA should ensure any new garages or renovations account for the transition to electric buses.

Investing in electrifying WMATA’s transit bus fleet should entail more than a financial calculus. Moving away from diesel and CNG buses over the next quarter century means investing in more than buses and related charging infrastructure.

It means investing in the people of Washington DC, Maryland, and Virginia who rely on WMATA’s buses to get to work and school, and just to go about their daily lives, and, more broadly, residents in these areas who

will benefit from cleaner air and reduced GHG emissions from transportation. Even using conservative estimates, electrification of WMATA’s fleet presents a win-win-win scenario: WMATA saves hundreds of millions of dollars in



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lifetime operating costs across the fleet; climate pollution from the fleet dramatically declines, helping Washington DC meet its climate goals while benefiting everyone; and DC area residents breathe cleaner air and save millions of dollars in avoided healthcare costs.

By prioritizing the deployment of electric buses and providing access to associated new green job opportunities in low- and moderate-income and environmental justice neighborhoods, WMATA can ensure the benefits of electrification are equitably distributed across its service territory. Prioritizing electrification of

these routes would help disadvantaged communities that disproportionately suffer the effects of smog and other pollution from cars, trucks, and buses. The climate crisis demands immediate action at the national and local level, and WMATA must develop a strong electrification plan that fully electrifies its fleet on clear timelines as transit agencies in other cities such as Chicago, New York, Seattle, and Los Angeles have already done. Our organizations stand ready to work alongside WMATA, and other stakeholders, as we move toward a clean transportation future for all DC area residents.

## ENDNOTES

- 1 WMATA's board of directors is comprised of composed of eight voting and eight alternate directors. The District of Columbia, Maryland, Virginia and the federal government each appoint two voting directors and two alternates. <https://www.wmata.com/about/board/>.
- 2 Washington Metropolitan Area Transit Authority, *Metrobus Fleet Management Plan at 20 (2017)* (hereafter "WMATA, Fleet Management Plan"). Links to cited materials are included in the Cited Literature section of the Appendix.
- 3 US Public Interest Research Group, *Electric Buses in America: Lessons from Cities Pioneering Clean Transportation*, 14 (Oct. 2019).
- 4 For modelling comparisons made throughout this paper, "WMATA Plan 2030," reflects the business-as-usual approach as set out in WMATA's 2017 fleet plan.
- 5 WMATA *Fleet Management Plan* at 5, 15.
- 6 See *infra* Part V.1., for citation and additional information for each city's transit electrification commitment.
- 7 WMATA, *Zero Emission Bus Update*, 2, 4.
- 8 <https://www.transit.dot.gov/funding/grants/fiscal-year-2020-low-or-no-emission-low-no-bus-program-projects>.
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- 10 US PIRG, *Lessons Learned* at 14. See *infra* Part V.1.
- 11 WMATA, *Zero Emissions Bus Update* at 2 (Feb. 2020); <https://www.wmata.com/initiatives/plans/upload/Bladensburg-General-Plans-Set.pdf>
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- 13 WMATA, *Fleet Management Plan* at 52.
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- 15 Government of the District of Columbia, *Clean Energy DC: the District of Columbia Climate and Energy Action Plan*, v (2018).
- 16 Government of the District of Columbia, Press Release, "Mayor Browser Signs Historic Clean Energy Bill, Calling for 100% Renewable Electricity by 2032," (Jan. 18, 2019).
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- 18 See sec. 502 of the Act, DC Code sec. 50-741. The Act also calls on DDOT to release a plan by July 1, 2021 to include recommendations on policies that would help achieve the transportation electrification timelines in the Act, increase vehicle registrations in Washington D.C. to at least 25 percent zero-emissions vehicles by 2030, and meet the goal of 100 percent replacement of public transit and school buses with electric buses upon the end of their useful life, by 2021.
- 19 WMATA, *Fleet Management Plan* at 13.
- 20 See *Fleet Management Plan* at 91 (breaking down WMATA's existing fleet by manufacturer and bus type).
- 21 US Public Interest Research Group, *Electric Buses in America: Lessons from Cities Pioneering Clean Transportation*, 11 (2019). Accord Quarles, N., *Costs and Benefits of Electrifying and Automating Bus Transit Fleets* (2020), [https://www.cae.utexas.edu/prof/kockelman/public\\_html/TRB18AeBus.pdf](https://www.cae.utexas.edu/prof/kockelman/public_html/TRB18AeBus.pdf).
- 22 The "WMATA 2030" scenario in this report's figures reflects a fleet composition in 2030 as set out in WMATA's 2017 Fleet Management Plan. Note that WMATA does not currently have a public fleet management plan that extends to 2040.
- 23 U.S. Environmental Protection Agency, "Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions, 1990-2017," at 1 (June 2019).
- 24 <https://www.mwcog.org/newsroom/2020/02/20/cog-board-supports-multi-state-effort-to-reduce-greenhouse-gas-emissions-from-transportation/>.
- 25 This analysis does not attempt to quantify fueling and charging infrastructure costs for any bus type, whether electric, CNG, or diesel, nor estimate how much infrastructure is necessary per bus. Even adding, conservatively, \$100,000 per electric bus for charging infrastructure, while assigning a \$0 value for CNG and diesel fueling, electric buses would still compare favorably over the lifetime of the bus.
- 26 AFLEET's total cost of ownership figures correspond very closely (and are slightly less than) WMATA's total cost of ownership estimates based on a medium fuel price assumption. See WMATA, *Fleet Management Plan* at 59.
- 27 To calculate fleet-wide cost savings, we took the per-bus cost analysis from section A., above, and extrapolated across bus type and various WMATA fleet compositions.
- 28 To estimate total cost of ownership in 2030 and 2040, this analysis factors in purchase price, fuel, and maintenance costs for a 15-year lifespan of each bus in the fleet. The numbers presented here provide a representative snapshot of future economic savings to WMATA without assigning which bus types are converted to electric in a given year. The lifetime cost savings from electrification presented here are conservative, using current purchase price for all bus types to guard against a critique of reliance on optimistic future price projections. Given market trends, purchase prices for electric buses will very likely continue to decrease significantly through 2030 and 2040 compared to any price shift for diesel, CNG, and hybrid buses, meaning that WMATA's cost savings will likely be higher than projected here.
- 29 This report uses WMATA's existing fleet size for both 2030 and 2040 comparisons.
- 30 WMATA *Fleet Management Plan* at 21, 25.
- 31 IPCC, *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways*, at Summary for Policymakers, p. 15 (2018).
- 32 *Id.*
- 33 National Oceanic and Atmospheric Administration, "July was hottest month on record for planet" (Aug. 15, 2019).
- 34 Maggie Gordon, "Repeat flooding has residents asking: Is Houston worth it?" *Houston Chronicle* (Sept. 20, 2019).
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- 37 Metropolitan Transit Authority, “MTA Deploys First All-Electric Articulated Bus Fleet to 14th Street Busway,” (Dec. 15, 2019).
- 38 Joel Linton, “LA City Approves Full LADOT Transit Electrification By 2030,” *Streets Blog LA* (Nov. 19, 2017), <https://la.streetsblog.org/2017/11/09/l-a-city-approves-full-ladot-transit-electrification-by-2030/>.
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- 40 Mischa Wanek-Libman, “Chicago City Council approves transition to 100% renewable energy,” *Mass Transit Magazine* (Apr. 15, 2019).
- 41 *Id.*
- 42 Kyle Hyatt, “Los Angeles’ order of 130 electric buses in largest in US history,” *Road Show* (Nov. 19, 2019).
- 43 New York Metropolitan Transit Authority, “MTA Deploys First All-Electric Articulated Bus Fleet to 14th Street Busway,” (Dec. 15, 2019).
- 44 <https://www.dashbus.com/zebfunding>.
- 45 In order to estimate annual CO<sub>2</sub> emissions for diesel, CNG, and hybrid uses, we used per bus CO<sub>2</sub> emissions rate data provided by the Federal Transit Administration, which details an emissions testing campaign using the models of buses used in WMATA’s fleet in 2013. WMATA’s 2017 Metrobus Fleet Plan estimates an average WMATA bus travels 33,000 miles per year, allowing us to estimate annual fleet on-road emissions based on WMATA’s existing and future fleet compositions. In order to calculate net emissions savings of electrifying WMATA’s fleet, we estimated grid emissions associated with electric bus charging utilizing the Renewable Portfolio Standards for Washington D.C. and Maryland. For non-renewable generation, we utilized conservative emissions estimates based on those from a typical combined-cycle gas plant.
- 46 Interagency Working Group on the Social Cost of Carbon, Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis—Under Executive Order 12866, at 17 (August 2016 Update), [https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc\\_co2\\_tsd\\_august\\_2016.pdf](https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf).
- 47 Several Washington D.C. area counties were deemed to be in non-attainment for compliance with the health-based NAAQS for ozone until April 2019, and continue to register days with pollution levels above the NAAQS’ health based pollution level. 84 Fed. Reg. 15108 (Apr. 15, 2019).
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- 57 *Id.*
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- 59 Environmental Protection Agency, DEQ Release Notes, (July 23, 2019).
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- 61 U.S. Public Interest Research Group, *Electric Buses in America: Lessons from Cities Pioneering Clean Transportation*, 13 (2019).
- 62 <https://www.cleanenergyworks.org/clean-transit/>.
- 63 Federal Transit Administration, “Low or No Emission Vehicle Program,” <https://cms7.fta.dot.gov/funding/grants/lowno>.
- 64 City of Santa Monica, Big Blue Bus’s First Electric Bus Is Here!, (Aug. 26, 2019).
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- 66 [https://www.metro.net/news/simple\\_pr/metro-leads-setting-2030-zero-emission-bus-goal/](https://www.metro.net/news/simple_pr/metro-leads-setting-2030-zero-emission-bus-goal/).
- 67 <https://www.sfmta.com/press-releases/san-francisco-commits-all-electric-bus-fleet-2035>.
- 68 King County Metro, Transitioning to a zero-emissions bus fleet, (Nov. 25, 2019).
- 69 <http://www.mta.info/press-release/nyc-transit/mta-deploys-first-all-electric-articulated-bus-fleet-14th-street-busway>.
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