



**Executive Committee**

**Board Action Item III-A**

**June 10, 2021**

# **Sustainability Vision and Principles and Metrobus Fleet Plan**

Washington Metropolitan Area Transit Authority  
**Board Action/Information Summary**

Action  Information

MEAD Number:  
202278

Resolution:  
 Yes  No

**TITLE:**

Sustainability and Metrobus Fleet Strategy

**PRESENTATION SUMMARY:**

Staff will present jurisdictional feedback on a sustainability vision and principles, proposed in November 2020, and request Board adoption. Staff will also provide information on the proposed Metrobus fleet strategy, discuss the proposed move to zero-emission vehicles, and request Board adoption of zero-emission vehicle goals.

**PURPOSE:**

To receive Board approval of a sustainability vision and principles; to provide information to the Board regarding the development of the sustainability vision and principles, the Metrobus Fleet Plan strategy; and to receive Board approval of zero emission vehicle goals.

**DESCRIPTION:**

The establishment of a sustainability vision and principles and zero-emission vehicle goals will provide a framework for policy and investment decision-making.

For purposes of the Board consideration of the Metrobus Fleet Strategy and establishing zero emission vehicle goals, please see the attached list of potentially interested parties.

**Key Highlights:**

- Metro has made progress on its sustainability goals by identifying and implementing initiatives that enhance sustainable investment, including but not limited to lighting improvements, the solar lease program, the Energy Action Plan, and the zero-emission bus program.
- A Board-adopted sustainability vision and principles will support a systematic approach to sustainability, including engaging stakeholders in strategic conversations regarding sustainability and supporting partnerships across the region.
- Adoption of a sustainability vision and principles aligns Metro with jurisdictional partners who are implementing sustainability and resilience policies to guide their operations, planning, and decision making.

- The Metrobus fleet strategy has the potential to reduce regional greenhouse gas emissions and improve local air quality.
- Metro is recommending three goals be established which will inform the development of the next Metrobus Fleet Plan:
  - Purchase only lower-emission and electric buses in next bus vehicle procurement
  - Transition to 100% zero-emission bus purchases by 2030
  - 100% zero-emission bus fleet by 2045
- Transition to zero-emission bus technologies will have impacts on fleet operations, capital costs, operating costs, maintenance, facilities and required facility and charging infrastructure investments.
- Electric bus technologies are expected to continue to mature; Metro will monitor and study this technology, including through the Electric Bus Test and Evaluation and other methods.

## **Background and History:**

### **Sustainability Vision and Principles**

Sustainability is a fundamental business approach at Metro that advances regional goals and provides social equity, economic and environmental benefits to the communities served. As a vital transportation link that occupies and connects communities, a major employer and purchaser of goods and services, and one of the region's largest energy consumers, Metro's investments and operational decisions have immediate and significant impacts on health, equity, economic prosperity, and the overall social and economic wellbeing of the region.

Cost-effective and data-driven sustainable business decisions provide Metro's funding partners with a strong return on investment, while also achieving mutually beneficial goals. By building, operating, and maintaining a safe, reliable, resilient and sustainable transit system, Metro enhances environmental stewardship, contains operating costs, and reduces energy use and regional emissions, all while improving the lives of residents and visitors.

### **Metrobus Fleet Strategy and Zero-Emission Goals**

Metro maintains a fleet of over 1,500 buses at ten operating divisions located throughout the region. This fleet consists of a mix of diesel, compressed natural gas, and diesel-electric hybrid buses, as well as one electric bus. Bus technologies continue to develop and mature, especially electric buses in recent years.

Metro regularly updates its Metrobus Fleet Management Plan to reflect current and future fleet operations, forecast anticipated ridership and network demand, detail upcoming bus procurement and retirement plans, and discuss systemwide maintenance and facility needs.

In 2019 alone, passengers took over 300 million trips on Metrorail and Metrobus. Every trip taken with Metro instead of a car reduces the region's greenhouse gas emissions and improves local air quality. The use of lower-emission and zero-emission vehicles would further reduce greenhouse gas emissions and benefit public health.

Metro's current bus procurement contract will end in FY2023. The next five-year procurement will be initiated in FY2022, with deliveries anticipated to begin in FY2024. The Board adopted 2017 Metrobus Fleet Plan calls for procurement of equal numbers of diesel and compressed natural gas buses. As electric bus technologies continue to mature, Metro can revise its long-term fleet strategy to include an expanded zero-emission fleet. Transition to zero-emission buses in Metro service will have impacts on Metro's capital costs, facilities, operations, and benefits to regional air quality and greenhouse gas emissions.

## **Discussion:**

### **Sustainability Vision and Principles**

Metro is committed to providing a sustainable transportation system – a system that meets the needs of people, communities, and businesses in the region, and fosters social wellbeing, equity, economic prosperity, and environmental stewardship.

Resilience and sustainability are at the forefront of transportation planning throughout the region. This planning requires an interconnected effort with regional partners and jurisdictions. Metro intends to advance this dialogue further by setting a sustainability vision and principles to help guide long range planning and investment decisions.

In November 2020, Metro presented draft sustainability principles to the Board. The draft principles recognize sustainability as a core value within Metro and drive decision-making to improve efficiency, reflect customer needs, further support regional sustainability, and align with industry best practice.

During the winter of 2020 and spring of 2021, staff gathered feedback on the proposed principles from the jurisdictions, which confirmed that the proposed principles are in alignment with regional goals.

Metro is focused on advancing transit and social equity across its operations and business through a Framework for Transit Equity with focus areas including: the Bus Transformation Project, DBE/MBE programs, public participation, and sustainability.

Metro is updating its sustainability targets to expand beyond traditional environmental targets to include targets related to equity, prosperity, livability,

and accessibility.

## **Metrobus Fleet Strategy and Zero-Emission Goals**

Of the approximately 55,000 public transit buses in operation in the United States, approximately 29,000 are diesel buses, 12,500 are compressed natural gas buses, 9,000 diesel-electric hybrid buses, 3,600 biodiesel buses, 600 electric trolleybuses, and 500 battery-electric buses in operation. An additional 500 battery-electric bus orders are pending.

Peer transit agency approaches to electric buses have included target year fleet commitments, test deployments and the monitoring of the development of the technology. In a survey of available electric bus pilot programs, electric buses have not yet demonstrated consistent reliability on par with conventional vehicles. Improvements in this area are expected as technologies scale and manufacturers respond to a shift in market commitments to electric buses.

Metro will continue to monitor electric bus range, availability, reliability and other performance factors with the expectation that electric buses will eventually be capable of replacing conventional buses on a one-for-one basis. Metro's upcoming Electric Bus Test and Evaluation, which will involve the procurement of approximately 12 electric buses in FY2023, will provide data and experience with electric bus performance in Metro operating conditions.

In considering the future of the Metrobus fleet, Metro projects its anticipated future service levels, fleet size, fleet composition and maintenance facility and operational needs. Metro typically procures 100 new buses per fiscal year while overhauling another 100 buses at their midlife. The proposed draft fleet strategy would maintain this approach while increasing the number of articulated buses in the fleet.

Metro's draft fleet strategy also proposes a phased conversion of the Metrobus fleet, investing in electric bus technology, facilities, and infrastructure in the coming years. Beginning in FY2024, Metro would purchase only lower-emission and electric buses. By FY2030, Metro would procure only electric or other zero-emission buses. Under this proposed strategy, the entire Metrobus fleet would be made up of zero-emission vehicles by FY2045.

The Metropolitan Washington Council of Governments (MWCOC) has identified ground-level ozone and particulate matter as the two most important pollutants harmful to health in the region. Ozone is formed by the interaction of nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs). The Washington region is not currently meeting standards for ozone, while it is meeting standards for particulate matter with occasional exceedance days.

By procuring vehicles which emit fewer harmful pollutants such as NO<sub>x</sub> and VOCs, the Metrobus fleet can contribute to regional air quality improvements.

The draft strategy would also reduce Metrobus fleet greenhouse gas emissions by an estimated ~56% by 2030 and an estimated ~78% by 2038. Electric buses are also quieter and vibrate less, offering increased passenger comfort and an improved riding experience.

Metrobus facilities are not currently configured to support an electric bus fleet. Capital investment in facility conversion and other electric bus support infrastructure will be required to begin the transition of the fleet. Facility requirements include charging equipment, garage configuration changes, support and coordination with electric utilities, parts and material storage and other operational and safety considerations. Metro will continue to coordinate with regional electric utilities, jurisdiction and transit providers as it advances future fleet and facility plans.

**FUNDING IMPACT:**

Adopting these sustainability vision and principles and the zero-emission fleet goals does not have a direct financial impact on the FY2022 Budget. A transition to a 100% zero-emission fleet and other sustainability projects and initiatives offer a transformational investment opportunity for Metro and the Region.

**TIMELINE:**

<p><b>Previous Actions</b></p>	<p>September 2017 - Adoption of 2017 Metrobus Fleet Management Plan</p> <p>July 2020 – Sustainability Initiative Update</p> <p>July 2020 – Transit Equity Framework</p> <p>November 2020 – Transit Equity Framework: Sustainability</p>
<p><b>Anticipated actions after presentation</b></p>	<p>Return to the Board with a Metrobus Fleet Plan that aligns with Metro’s sustainability vision and principles and zero emission vehicle goals.</p>

**RECOMMENDATION:**

Staff recommends approval of the sustainability vision and principles and the zero emission vehicle goals.

## Potentially Interested Parties List

### Metrobus Fleet Plan strategy and zero emission vehicle goals

#### Currently under contract:

- AECOM
- BAE Systems Controls, Inc.
- Center for Transportation and the Environment
- CH2M HILL, Inc.
- Clark Construction Group, LLC
- CRW Parts, Inc.
- Cummins, Inc.
- Dartco Transmission Sales & Service, Inc.
- Direct Machinery Outlet, Inc.
- Genfare
- Gillig Corporation
- Hensel Phelps Construction Co.
- James River Petroleum (JRP)
- Johnson & Towers Baltimore, Inc.
- Laird Plastics, Inc.
- Lytx, Inc.
- Modine Manufacturing Company
- Needles Eye
- Neopart Transit, LLC
- New Flyer of America, Inc.
- Northeastern Bus Rebuilders, Inc.
- P & H Auto-Electric, Inc.
- RAM Industrial Services, Inc.
- The Aftermarket Parts Company, LLC
- Tri-state Battery & Auto Elec., Inc.
- WSP

#### Other potentially interested parties:

- A123 Systems
- Baltimore Gas & Electric Company – an Exelon Company
- BYD Motors, Inc.
- Daimler
- Dominion Energy, Inc.
- ElDorado National
- Leclanché
- Microvast Power Solutions, Inc.
- Novabus
- Pepco – an Exelon Company
- Proterra
- Van Hool
- Washington Gas – a WGL Company
- XALT Energy

# Sustainability Vision and Principles and Metrobus Fleet Strategy

Executive Committee  
June 10, 2021





## Agenda

- Review Final Draft Sustainability Vision and Principles
- Review Draft Metrobus Fleet Strategy
- Recommend Board approval of Sustainability Vision and Principles and Zero-Emission Fleet Goals

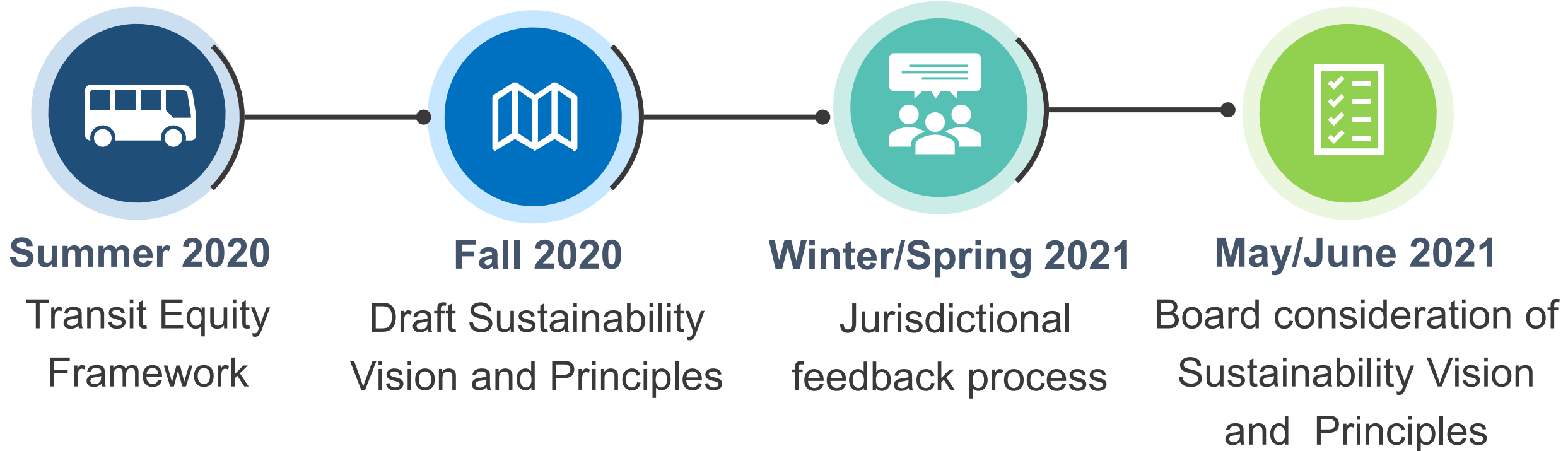




# Sustainability Vision and Principles



# Sustainability Vision and Principles - Timeline



# Draft Sustainability Vision and Principles Provide Framework for Policy and Investment Decisions

Recognize sustainability as a core value at Metro

Support cost-effective and data-driven decisions

Advance regional sustainability and resilience goals

Engage strategically with partners

Help guide long range planning and investment decisions

Support livable communities – improve equity, the environment, access to opportunity

## Regional Framework

- WMATA is central to regional sustainability and zero emission bus implementation
- Governmental and business policies advance sustainability
  - Climate plans
  - Procurement requirements
  - Building regulations
  - Electric bus programs
- Goals include
  - Reduce carbon emissions
  - Increase efficiency
  - Racial and social equity
  - Fiscal responsibility



# Regional Sustainability Policies and Legislation

## Maryland

### State of Maryland

- Clean Energy Jobs Act
- Renewable Portfolio Standards
- Climate change adaptation plans
- Electric Vehicle Infrastructure Council
- Greenhouse Gas Reduction Act  
Plan targets 50% zero-emission MDOT MTA fleet by 2030

### Montgomery and Prince George's Counties:

- Local climate adaptation and mitigation plans
- Electric bus FTA pilot grantees
- Montgomery County Carbon Neutral by 2035, solar-integrated Brookville bus depot to support electric buses, Draft Climate Action Plan proposes 100% zero emission public transit by 2035
- Prince George's County carbon reduction goal of 80% below 2008 levels by 2050

## Virginia

### Commonwealth of Virginia

- Clean Economy Act
- Carbon neutral grid by 2050
- Permanent Council on Environmental Justice
- Electric School Bus Statewide Partnership

**Arlington County:** Carbon neutrality 2050, Renewable energy purchase

**Fairfax County:** Climate Action Plan and Environmental strategy

**Loudoun County:** Energy and conservation strategy

**City of Alexandria:** Electric Bus Pilot, ECO-City strategic program, Environmental Action Plan targets overall 50% greenhouse gas emissions reduction by 2030, 80-100% reduction by 2050, and 100% zero-emission DASH fleet by 2037

## District of Columbia

### District of Columbia

- Carbon neutrality by 2050
- Sustainable DC and Clean Energy DC plans
- Clean Energy Act: 100% of the public buses to be zero-emission by 2045
- Transportation Benefits Equity Act

**DDOT:** Sustainability and Resiliency Plans. Environmental policy and equity program. Circulator operates electric buses

Federal fleet requirements continuing to focus on electric and lower-emission vehicles, reduced GHG emissions, and support for cleaner and more renewable forms of energy.  
Regional transit providers continue to invest in and explore electric buses, electric buses as share of fleets to grow in coming years.

# Jurisdictional Feedback

Presented to Joint Coordinating Committee (JCC) and met with jurisdictional elected officials and staff

## What we heard:

- Transit is understood to be an essential partner in achieving regional goals
- Proposed principles are in alignment with jurisdictional objectives including:
  - Reducing carbon emissions
  - Increasing efficiency
  - Addressing racial and social equity
  - Enhancing fiscal responsibility



# Draft Sustainability Vision for Board Consideration

WMATA provides a sustainable transportation system that meets the needs of people, communities, and businesses in the region, and fosters social wellbeing, equity, economic prosperity, and environmental stewardship.





# Draft Sustainability Principles for Board Consideration

Develop and implement an **Action Plan** with specific priorities, strategies and targets to advance sustainability at WMATA and in the region

Recognize that our investments and operational decisions change lives. Make those decisions intentionally to **address historical, social, environmental, economic disparities, and racial and social injustice**

Build, operate and maintain a resilient transportation system to **improve livability, public health, the environment, equity, and access to opportunity**

Leverage the special nature of WMATA's service and our unique market position to **advance regional goals**

# Draft Sustainability Principles for Board Consideration

Make **cost-effective and data-driven business decisions** that provide WMATA and our partners with the best return on their investment

Advance the region's sustainability efforts by leading **transparent and authentic collaboration** with stakeholders and community partners

Foster a **culture of** continuous improvement by growing staff capacity and leveraging regional expertise and **innovation**

Establish measurable **performance indicators** to track implementation and successes of WMATA's strategies and actions



# Metrobus Fleet Strategy



# Metrobus Fleet Strategy Review

- Present for Board consideration draft strategy for transition to zero-emission buses
- Reflects previous and ongoing staff engagement with local, national, international transit operators, bus manufacturers, and other stakeholders
- Recommend Board adoption of zero-emission fleet goals
  - Purchase only **lower-emission and electric buses** in next bus vehicle procurement
  - Transition to **100% zero-emission bus purchases by 2030**
  - **100% zero-emission bus fleet by 2045**

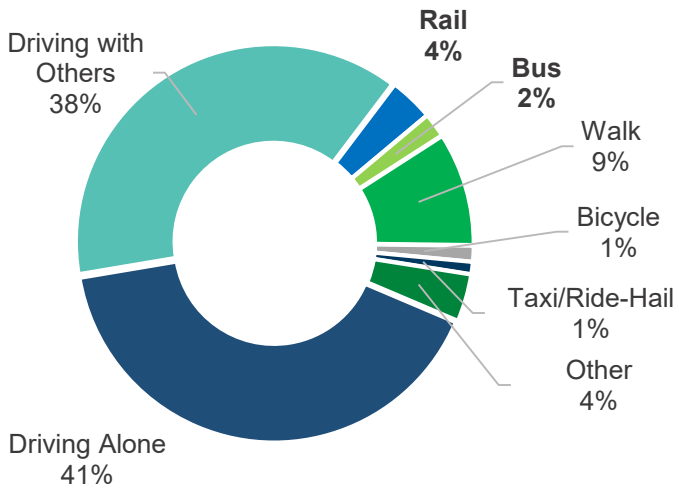
# Transit Ridership Reduces Emissions

- In 2019 alone, passengers took over **300 million trips** on Metrorail and Metrobus. Every trip taken with Metro instead of a car reduces greenhouse gas emissions, helps ensure clean air in the region.
- Metrorail and Metrobus trips in 2019 displaced over **300,000 metric tons of CO<sub>2</sub>**.

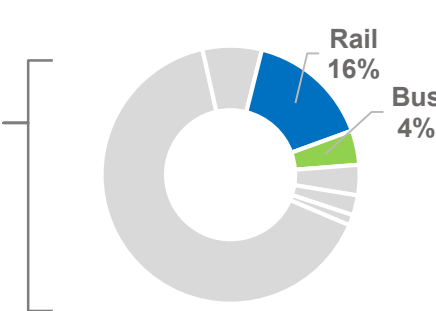
  - Bus trips emit ~25% less per mile compared to a single-occupancy car.
  - Rail trips emit ~65% less per mile compared to a single-occupancy car.
- Every 1% percentage point increase in public transit as a share of regional trips would reduce GHG emissions by **~125,000 metric tons per year**.

  - ~75,000 metric tons if this ridership increase occurred with a proportional increase in service (i.e., more buses and trains running).
- Lower-emission vehicles represent an opportunity to **further reduce regional greenhouse gas emissions and improve local air quality**.

Travel Mode, Share of All Weekday Trips



Commuter Trips Only



National Capital Region Transportation Planning Board  
2017-2018 Regional Travel Survey

Travel mode	Pounds of CO <sub>2</sub> / mile
Drive alone	~0.95
Metrobus	~0.70
Metrorail	~0.35

U.S. Department of Transportation Federal Transit Administration  
Public Transportation's Role in Responding to Climate Change



# Metrobus Fleet Strategy Key Questions

1. **What level of service** does Metro expect to supply in the future?
2. **How many buses** should Metro operate to meet demand and service requirements?
3. **What types of buses** should Metro operate?
4. **How will Metro's maintenance facilities and operations** meet evolving fleet needs?

## Context

- Opportunity to support regional recovery, equity and the environment
- Uncertainty of ridership and travel patterns in context of Covid-19
- Reconstruction of Bladensburg and Northern bus garages, addition of CNG fueling at Shepherd Parkway
- Bus Transformation Project recommendations and upcoming network redesign
- Regional targets for zero-emission bus fleets
- Current procurement contract has 2 years remaining. Next 5-year procurement will launch in FY2022 with deliveries beginning in FY2024.



# Metrobus Fleet and Facility Capacity

- Current policy (Board-adopted 2017) for new bus purchases is a **50/50 split of diesel and compressed natural gas (CNG) buses.**
- **Current procurement contract has 2 years remaining.** Next 5-year procurement will launch in FY2022 with **deliveries beginning in FY2024.**

Propulsion Technology	Bus Count	Buses as Share of Total Fleet	% of Total Garage Capacity
Diesel-Electric Hybrid	848 buses	55%	100%
Compressed Natural Gas	443 buses	29%	28%
Diesel	249 buses	16%	100%
Electric	1 bus	< 1%	< 1%

CNG fueling capacity and electric bus charging capacity to be added at Shepherd Parkway.

# Bus Fleet Management Approach

- Steady state procurement of **100 new buses per year** and midlife overhaul of 100 buses
- Typical **15-year useful life**
- **Benefits of this approach include**
  - Stable average fleet age contributing to reliable and consistent performance
  - Efficient application of resources for commissioning and overhauling buses
  - Reflects best practices for asset management





# Why Consider Electric Buses?

Benefits for regional air quality, customer experience



Cleaner air, reduced greenhouse gas and tailpipe emissions



Quieter vehicles, less vibration, increased passenger comfort



Decreased use of fossil fuels, reduced fuel costs



## Local Air Quality Context

**Metrobus fleet can help drive regional air quality improvements**

The Metropolitan Washington Council of Governments (MWCOCG) identifies ground level **ozone** and **particulate matter** as the two most important pollutants harmful to health in the region

Ozone is formed by interaction between nitrogen oxides (NOx) and volatile organic compounds (VOC)

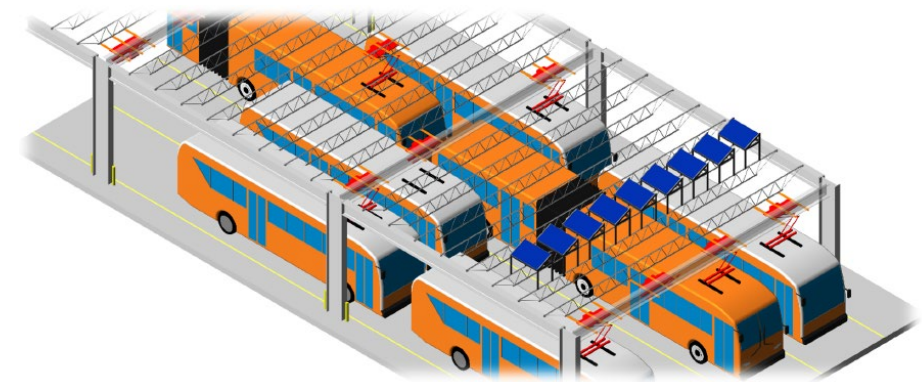
Region not meeting standards for ozone, is meeting standards for particulate matter with occasional exceedance days

Other pollutants tracked include carbon monoxide, for which region meets all standards



# Electric Buses: Industry-wide momentum, varied approaches to adoption

- Of ~55,000 U.S. transit buses: approximately 29,000 diesel, 12,500 CNG, 9,000 diesel-electric hybrid, 3,600 biodiesel, 600 electric trolleybuses, **500 battery-electric buses** with an additional **500 additional battery-electric bus orders pending**
- Regional targets and regulations encouraging or requiring fleet conversion
- Peer approaches include
  - Full commitment to 100% zero-emission fleet, infrastructure support
  - Test deployments to evaluate technology in operation
  - Wait-and-see approach as technologies mature



LA Metro Bus Division Overhead Charging Concept

# Current and Upcoming Electric Bus Activities

- **Electric Bus Test & Evaluation**

- Pilot program operating out of Shepherd Parkway to include deployment, testing and evaluation of ~10 standard-length electric buses and ~2 articulated electric buses.
- Project work is ongoing, with bus deliveries expected in early FY2023 and project closeout completed by mid-FY2024.

- **Continued Coordination with Electric Utilities**

- Staff working with local electric utilities to define future fleet electrification requirements and outline requirements for successful integration with grid infrastructure.

- **Evaluation of Additional Funding Sources**

- Staff reviewing potential opportunities for funding support of electric bus technology adoption, including federal programs and grants.

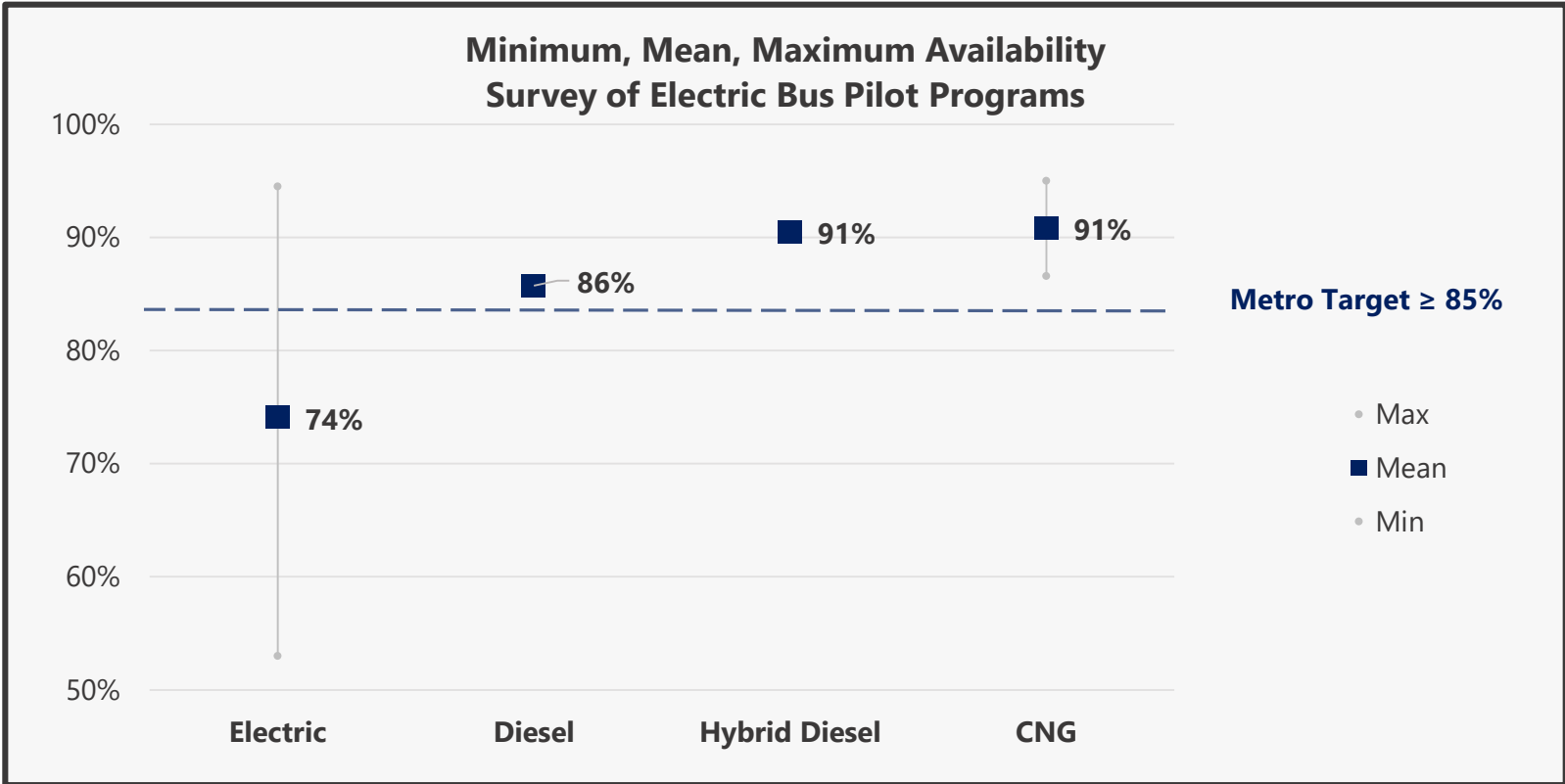


# Current and Upcoming Electric Bus Activities

- **Upcoming Five-Year Bus Procurement**
  - Development of Metro's next five-year bus procurement contract, including vehicle specifications.
  - Initial procurement development is ongoing, with issuance of request for proposals expected in FY2022. Contract bus deliveries to begin in FY2024.
- **Hiring of Program Management Team**
  - Expansion of staff support required to manage program associated with fleet electrification. Hiring activities underway.
- **Planning and Capital Project Development for Garage Electrification**
  - Development and evaluation of capital projects to expand Metro capacity to support, maintain, charge and store electric buses. Identification of sequencing and timing of garage conversion to support future fleet needs.
- **Exploration of Potential Hydrogen Fuel Cell Bus Test and Evaluation**
  - Staff to review potential program structure, implementation options and funding sources for test and evaluation of hydrogen fuel cell bus technologies.

# Battery Electric Bus Availability, Survey of Pilots

Electric buses have not yet demonstrated consistent reliability on par with conventional vehicles



Improvements expected as technologies scale, market commitments shift to electric buses and manufacturers respond






Survey of publicly available industry test and evaluation data 5 manufacturers (4 electric), 96 buses (49 electric), 6 peer agencies



# Metro Advancing Electric Bus Plans, Monitoring Technology

Expectation is electric buses will eventually be capable of 1-for-1 replacement of conventional buses

Every year, Metro’s bus fleet covers 50 million miles and delivers 3.7 million hours of service

Performance Factor		Present	Target
	Miles/hours of service	Limited demonstration data suggests <b>~15,000-20,000 miles/year</b>	On par with conventional vehicles <b>~30,000 miles/year</b>
	Availability	Demonstrated availability averages <b>~75%</b>	On par with conventional vehicles <b>~Available 85% of days</b>
	Reliability	Limited demonstration data suggests <b>~2,500-5,000 miles between failures</b>	On par with conventional vehicles, Metro target <b>~7,000 miles between failures</b>
	Travel range	In ideal operating conditions <b>~150 miles</b>	On par with conventional vehicles <b>~250+ miles</b>
	Useful life	Useful life assumption of <b>12 years</b>	On par with conventional vehicles <b>15 years</b>

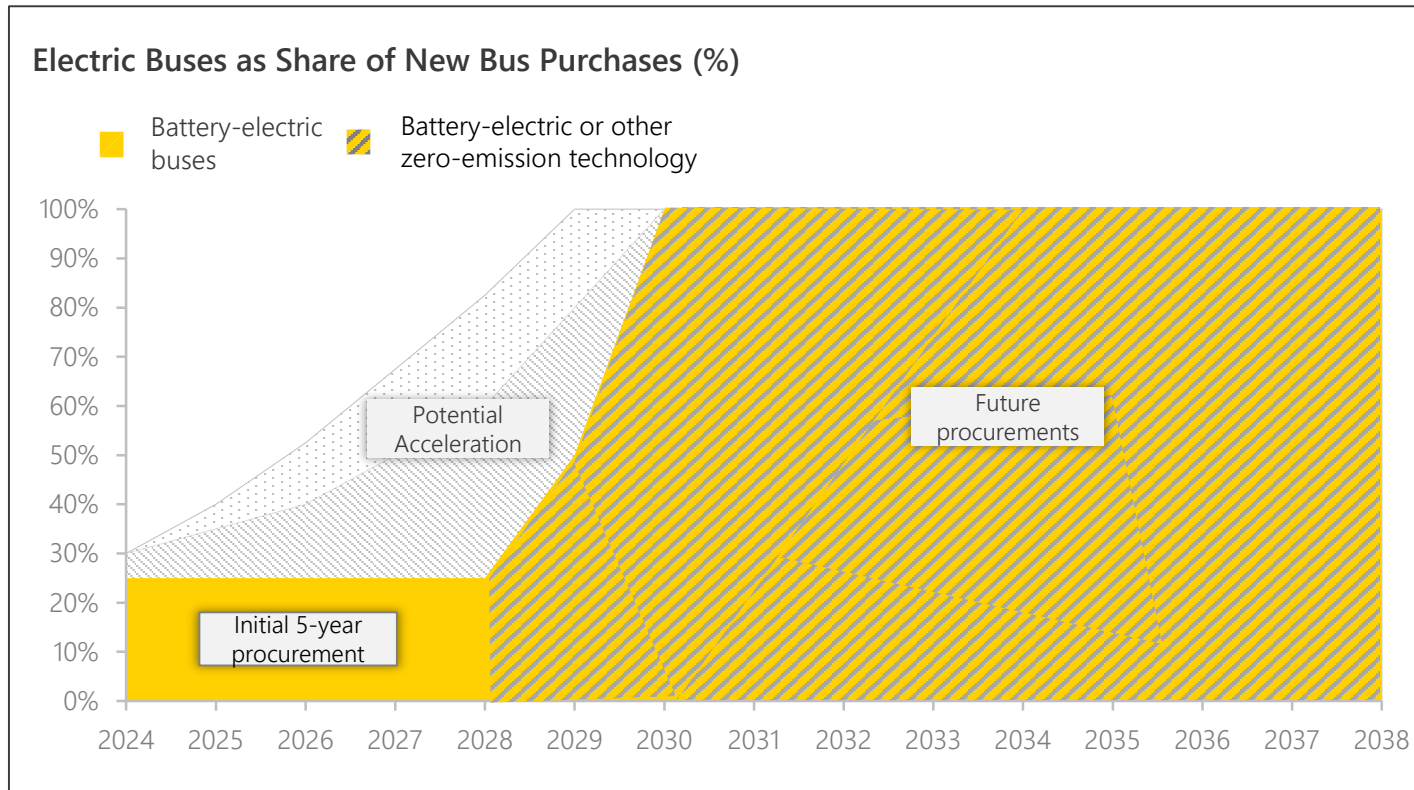
Upcoming Electric Bus Test and Evaluation will provide data and experience with electric bus performance in Metro operating conditions



# Draft Strategy: Metrobus Fleet Summary

- **Begin adoption of electric buses**, starting with next bus procurement, and transition new bus procurement to 100% electric or other zero-emission technologies by 2030, fleet fully zero-emission by 2045
- Maintain **steady state** fleet size of approximately 1,593 buses, procuring 100 new vehicles per year
- **Articulated Buses:** Grow share of overall bus fleet from current **4% to 12%**, or 180 buses, to address crowding and improve capacity on high ridership corridors
- **Spare ratio of 19.5%**, changed from current 18.5%, to support bus technology transition, increase in articulated buses, reduced garage and fleet flexibility, and increased capital program support needs (e.g., Platform Improvement Project)

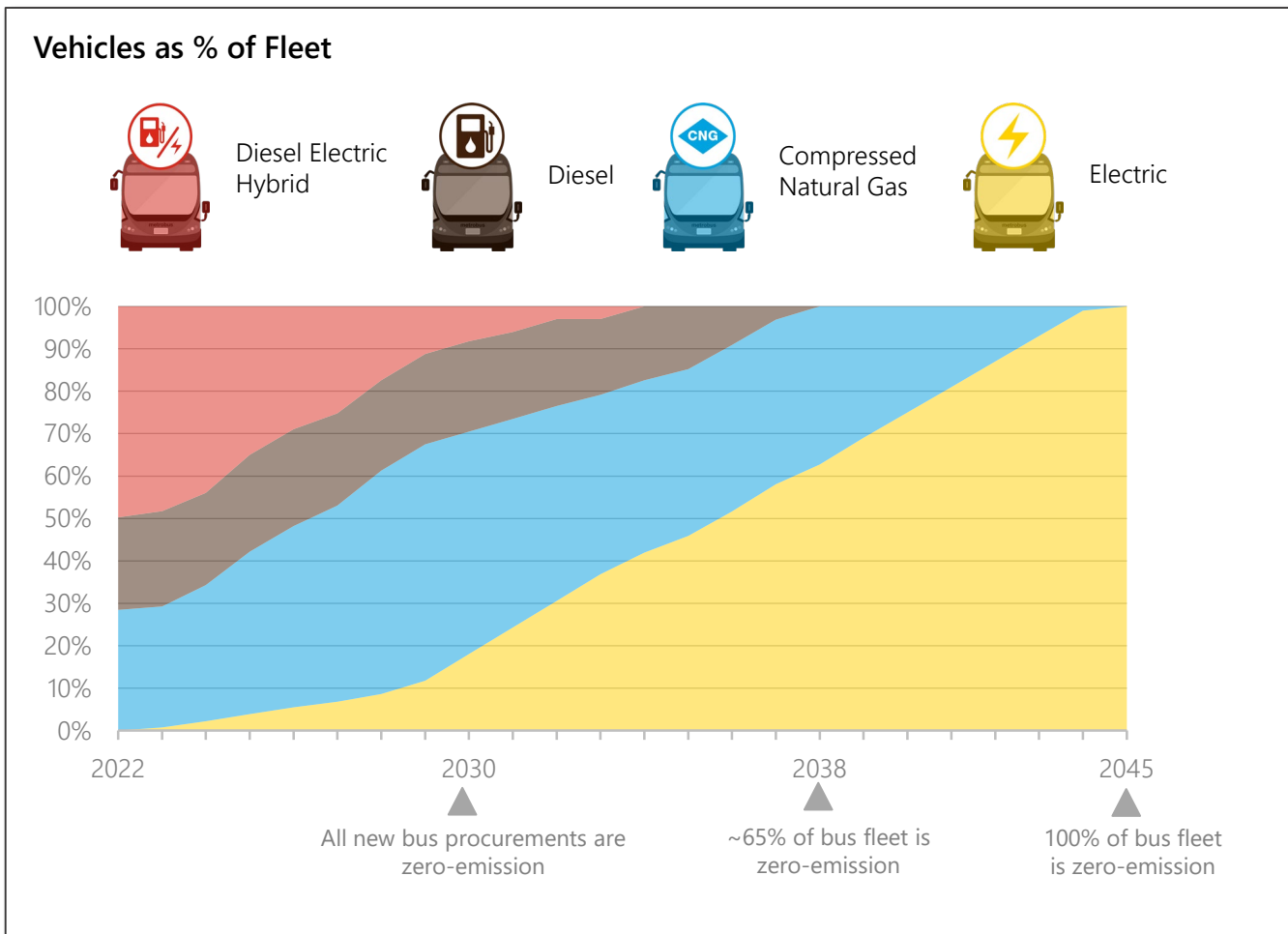
# Draft Strategy: Bus Procurement



- Draft Bus Fleet Strategy contemplates **phased approach** to electric bus adoption
  - Purchase only **lower-emission and electric buses** in next bus procurement
  - Transition to **100% zero-emission bus purchases by 2030**
  - Fleet **100% zero-emission by 2045**
- Draft Strategy weighs flexibility and adaptability with the potential for faster adoption of electric or other zero-emission buses if:
  - 1-for-1 replacement is possible sooner
  - More funding is available
  - Facility capacity and infrastructure improvements are realized more quickly



# Draft Strategy: Fuel Mix Implications



- **Flexibility and adaptability** considered in draft strategy, especially as technologies emerge and develop
- Draft target of 100% of new bus procurements to be **zero-emission by 2030**, **~65% zero-emission fleet by 2038**, **100% zero-emission fleet by 2045**
- Hydrogen fuel cell and other zero-emission bus types considered and evaluated in future



## Draft Strategy: Electric Bus Support, Facility Requirements

Conversion of Metro facilities to support electric buses requires investment

- **Charging equipment:** Chargers (plug-in, pantograph, etc.), conduits, transformers and other equipment must be installed in each garage offering electric bus support.
  - Potential exploration of in-route charging infrastructure, depending on deployment factors and fleet needs
- **Garage configuration:** Ceiling height, parking, and maintenance area dimensions and layouts likely to impact support for new bus technology.
- **Workforce opportunities and collaboration with labor:** New vehicle technologies will require new maintenance skillsets and training protocols, offer new skills and job training opportunities for workforce in the region.
- **Parts and materials storage:** New bus technology requires new parts inventories and other supporting materials and equipment.
- **Operational and safety considerations:** Time required for charging, operator role in bus charging likely to impact operations and require planning and review. Further modifications expected to ensure facility safety.

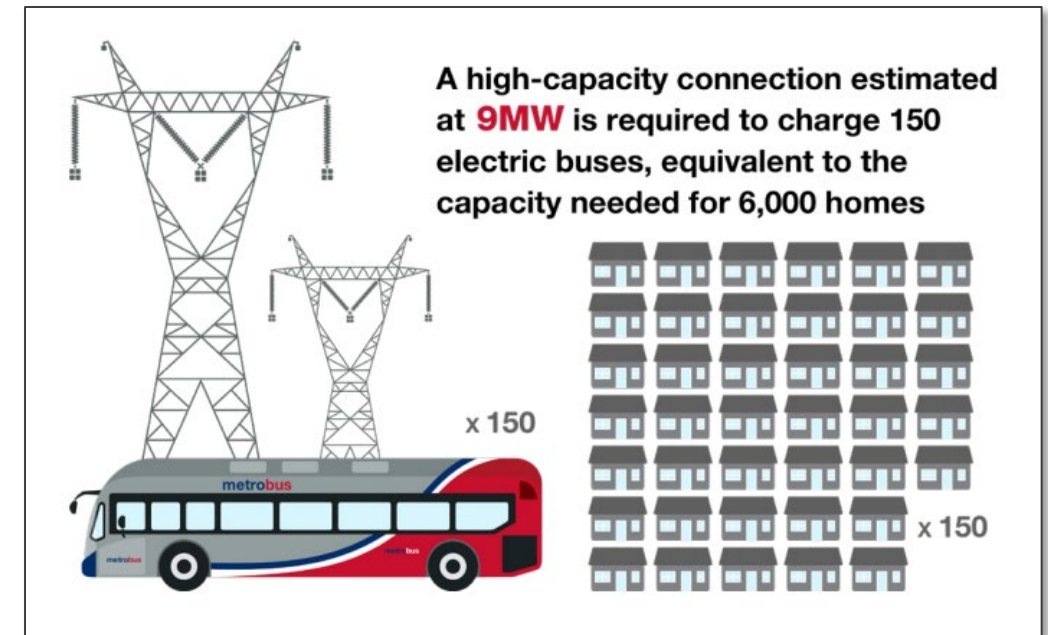
**Facilities are the critical path to transition**  
Some factors within Metro's control, others to require regional coordination and support



Conceptual design of Division Charging Infrastructure  
Source: LA Metro, ZEBGO December 2019

## Draft Strategy: Electric Utility Support Requirements

- **9 megawatts of high-capacity electric connection** required to support a garage of 150 electric buses. This level of support exceeds the capacity of existing localized grid connections.
- **Average Metro operating division** currently houses 150-160 vehicles, with capacities as low as 83 and as high as 300 when Bladensburg construction work is complete.
- Time of day and peak demand fees for charging introduce additional complexity.
- Collaboration to address frameworks for **shared charging infrastructure, utility investment requirements and funding responsibilities**. Equitable electric **rate structure** to ensure economic viability of electric bus fleet.



Source: Metro Zero-Emission Bus Update

# Draft Fleet Strategy: Transformational Investment Opportunity

- Increased capital costs:
  - Electric bus acquisition cost approximately **~\$300,000** higher (~45%) than diesel bus.
  - Average infrastructure cost per electric bus of **~\$400,000** per bus, based on preliminary peer agency project cost estimates. Suggests approximate project cost of **~\$60m** for single 150-bus garage.
  - Approach to support electric charging infrastructure likely to differ by location:
    - Incremental addition to active major projects (e.g., Northern, Bladensburg). Lower incremental cost than retrofit or facility replacement.
    - Retrofitting of existing facilities (e.g., Andrews Federal Center, Four Mile, Shepherd Parkway).
    - Conversion likely to require facility replacement (e.g., Western).

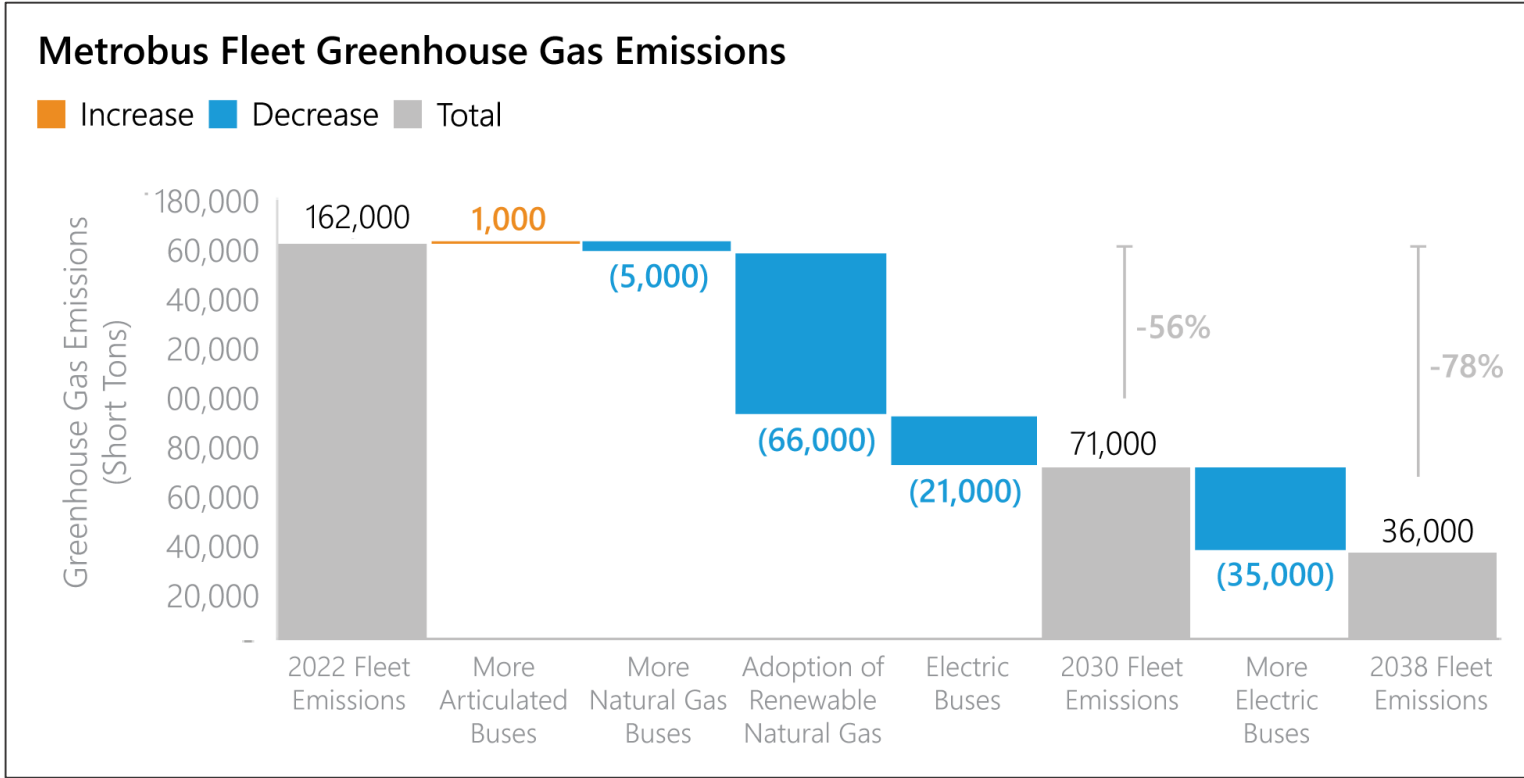
Figures represent order of magnitude estimates based on external benchmarks and experiences of peer transit agencies. Not official estimates; additional work required for development of projects at Metro facilities.

**Draft Strategy Order of Magnitude Estimated Incremental Capital Costs**

Period	Incremental Capital Cost Estimate
6-Year Capital Program (FY22-FY27)	~\$125-200m
10-Year Capital Plan (FY22-FY31)	~\$400-500m
Draft Fleet Strategy (FY22-FY38)	~\$900m-1b



# Draft Strategy: Emissions Implications, Greenhouse Gases



Source: EPA bus emissions data and 2020 Department of Energy Argonne National Laboratory model.

- Every trip taken with Metro instead of a car reduces the region’s greenhouse gas emissions; **lower-emission vehicles provide additional benefit**
- Addition of **electric buses**, expansion of **CNG fleet**, adoption of **renewable natural gas** drive greenhouse gas emission reductions
- Estimated **~56% reduction** in annual emissions by 2030, **~78%** reduction by 2038



# Policy Questions and Considerations

- Should Metro target converting its bus fleet to be 100% zero-emission vehicles?
- At what pace should Metro convert its fleet?
  - Metro will acquire ~12 electric buses for test and evaluation, joining the fleet in early FY2023
  - Draft fleet strategy proposes beginning annual acquisition of electric buses beginning in FY2024, sets 2030 as target year to begin procuring only zero-emission vehicles, and 2045 as target year for full fleet conversion
- Should Metro use lower-emission bus technologies, including compressed natural gas, during the transition period, which would reduce greenhouse gas emissions and local pollutants compared to diesel-fueled buses?
- Beyond currently planned electric-bus ready facility designs, should Metro incorporate electrification infrastructure into active major capital projects to replace Northern and Bladensburg?

# Recommendations

- Board approval of Sustainability Vision and Principles
  
- Board approval of Zero-emission Vehicle Goals
  - Purchase only **lower-emission and electric buses** in next bus vehicle procurement
  
  - Transition to **100% zero-emission bus purchases by 2030**
  
  - **100% zero-emission bus fleet by 2045**



# Appendix

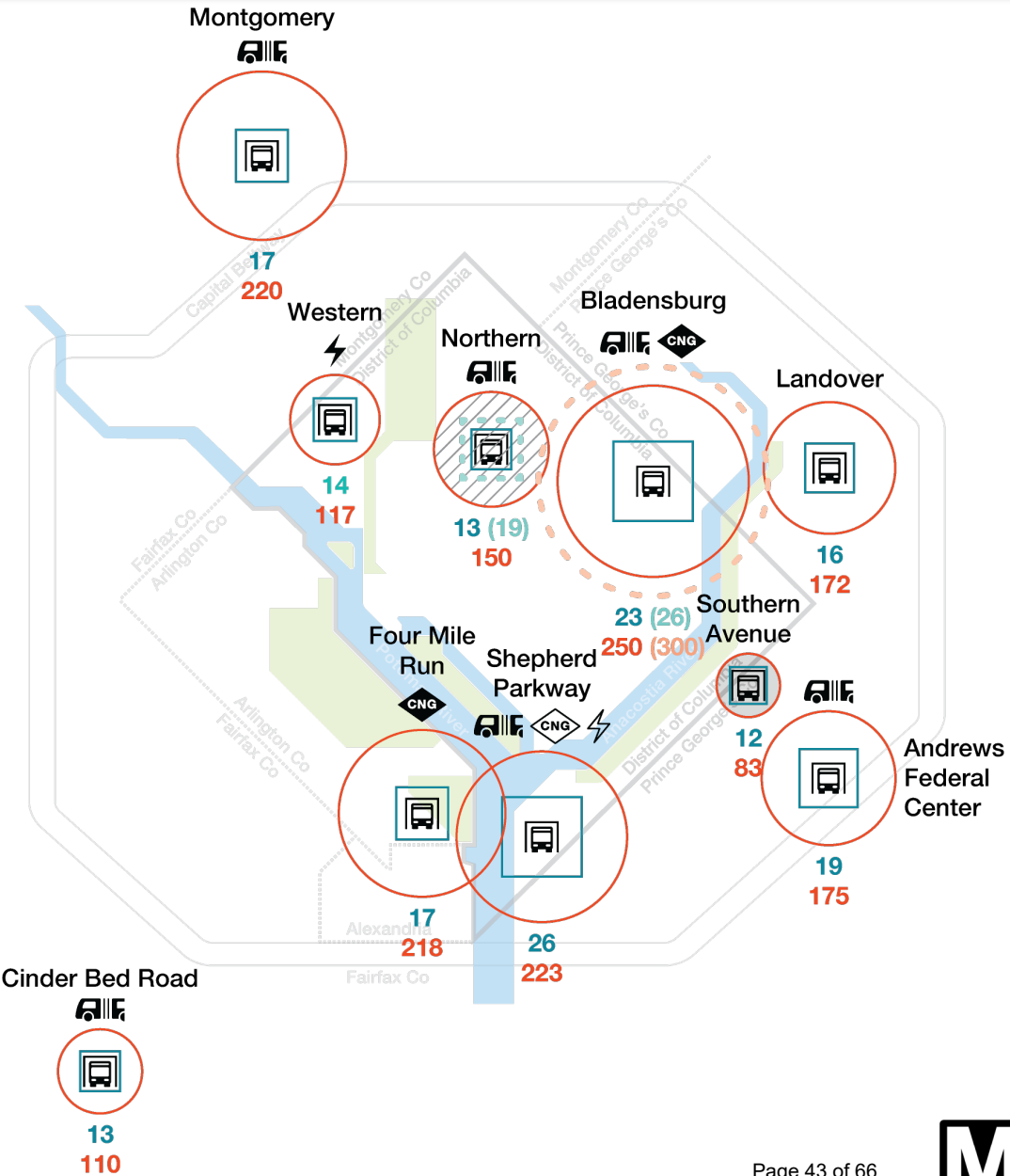







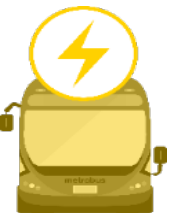

# Metrobus Facility Capacity

**Legend**

- Bus Division
- Current Bus Parking Capacity
- Planned Bus Parking Capacity
- Maintenance Bays
- Planned Maintenance Bays
- Division Slated to Close
- Division Currently Closed for Reconstruction
- Articulated Bus Maintenance Bays
- Compressed Natural Gas (CNG)-Capable
- CNG Capability Pending
- Electric Bus Home Garage
- Electric Bus Home Garage Pending



# Vehicle Technology Overview

Internal Combustion Engine	Hybrid	Electric Motor
<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Diesel</p> </div> <div style="text-align: center;">  <p>Compressed Natural Gas</p> </div> </div> <p>Powered by internal combustion, fossil fuel</p> <p>Diesel vehicles generally product higher greenhouse gas emissions, CNG vehicle emissions may be reduced through renewable natural gas</p> <p>High operational familiarity</p>	<div style="text-align: center;">  <p>Diesel-Electric Hybrid</p> </div> <p>Utilizes combination of internal combustion engine and electric propulsion system to power vehicle</p> <p>Incremental emissions benefits compared to diesel</p> <p>Two systems to maintain</p>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Battery-Electric</p> </div> <div style="text-align: center;">  <p>Hydrogen Fuel Cell</p> </div> </div> <p>Use electricity from different sources to power vehicle in operation</p> <p>Notable emissions reductions</p> <p>Emerging technology, not yet mature</p>

## Lower-Emission Buses

# Compressed Natural Gas and Diesel-Electric Hybrids

### CNG vehicles:

- Fuel costs ~**65%** lower than conventional diesel buses
- ~**28%** lower greenhouse gas emissions compared to conventional diesel
- NOx emissions ~**95%** lower than diesel (since new low-NOx engines in 2016)
- VOC emissions ~**40%** lower than diesel
- Opportunity to convert fuel source to **renewable natural gas**, which reduces greenhouse gas emissions to ~**85%** lower than diesel



### Hybrid vehicles:

- Primarily diesel fuel powered
- Fuel costs ~**20%** lower than conventional diesel buses
- ~**20%** lower greenhouse gas emissions compared to conventional diesel
- NOx and VOC emissions comparable or slightly lower than conventional diesel
- Can be stored, fueled and maintained at any Metrobus operating division



Draft fleet strategy proposes mix of electric and **lower-emission vehicle purchases during transition period to zero-emission buses**, reducing greenhouse gas emissions, improving local air quality, and lowering overall fuel costs

# Why Consider Compressed Natural Gas Buses?

Lower emission vehicles enable greenhouse gas and local pollutant reduction

- **Improved air quality**  
Lower emission alternative to other conventional vehicle technologies, new Low NOx CNG engines certified by U.S. EPA and California Air Resources Board (CARB) reduce harmful NOx pollutants by ~95% as of 2016
- **Proven propulsion technology**  
Metro has experience operating and maintaining CNG buses, building predictability into future fleet performance
- **Reduced fuel costs**  
Approximate ~65% reduction in fuel costs per bus mile compared to diesel buses
- **Enable transition to Renewable Natural Gas (RNG)**  
Use of renewable natural gas offers further reduction in fleet's upstream greenhouse gas emissions

## Renewable Natural Gas (RNG)

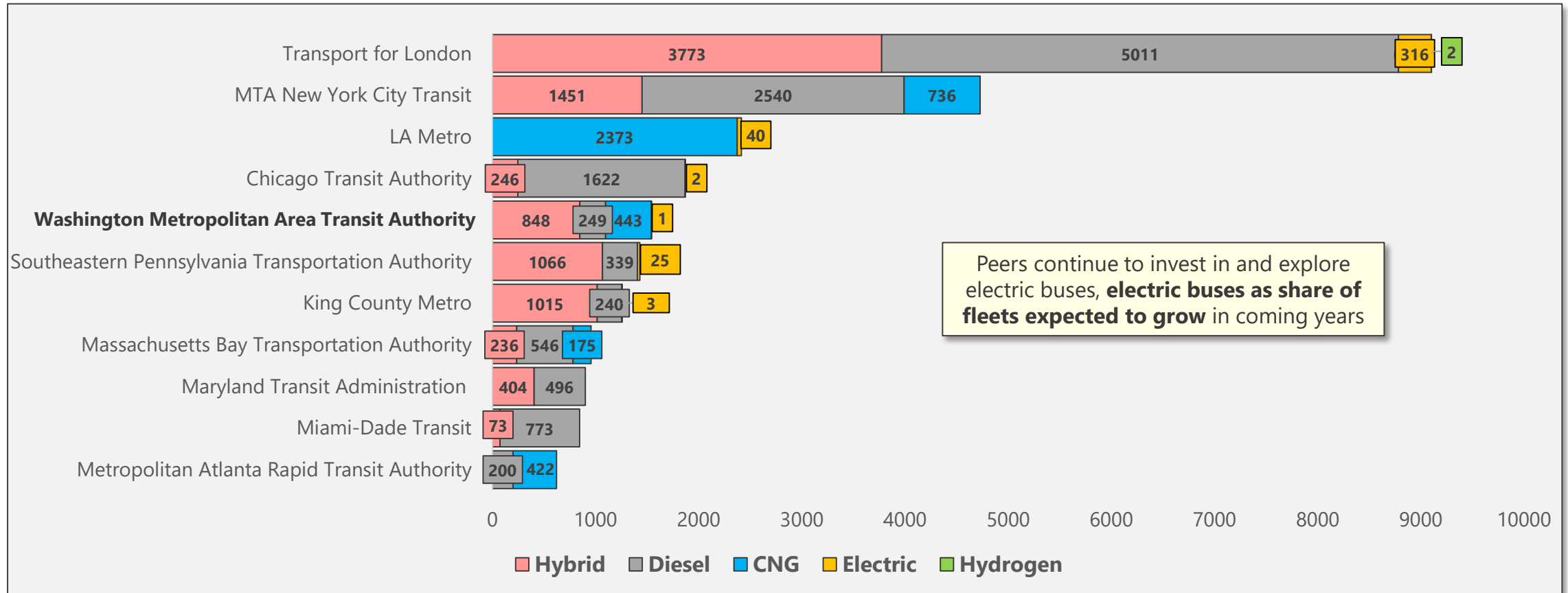
Generated through the capture and processing of biogas, which is produced through the decomposition of organic matter

Sources include methane from farming and animal waste, landfills, and wastewater treatment facilities

Metro has initiated procurement of renewable natural gas as part of emission reduction goals

Washington Gas actively developing utilization of RNG in the region, usage encouraged by U.S. EPA as method of reducing emissions

# Fleet Composition, Peer Transit Agencies



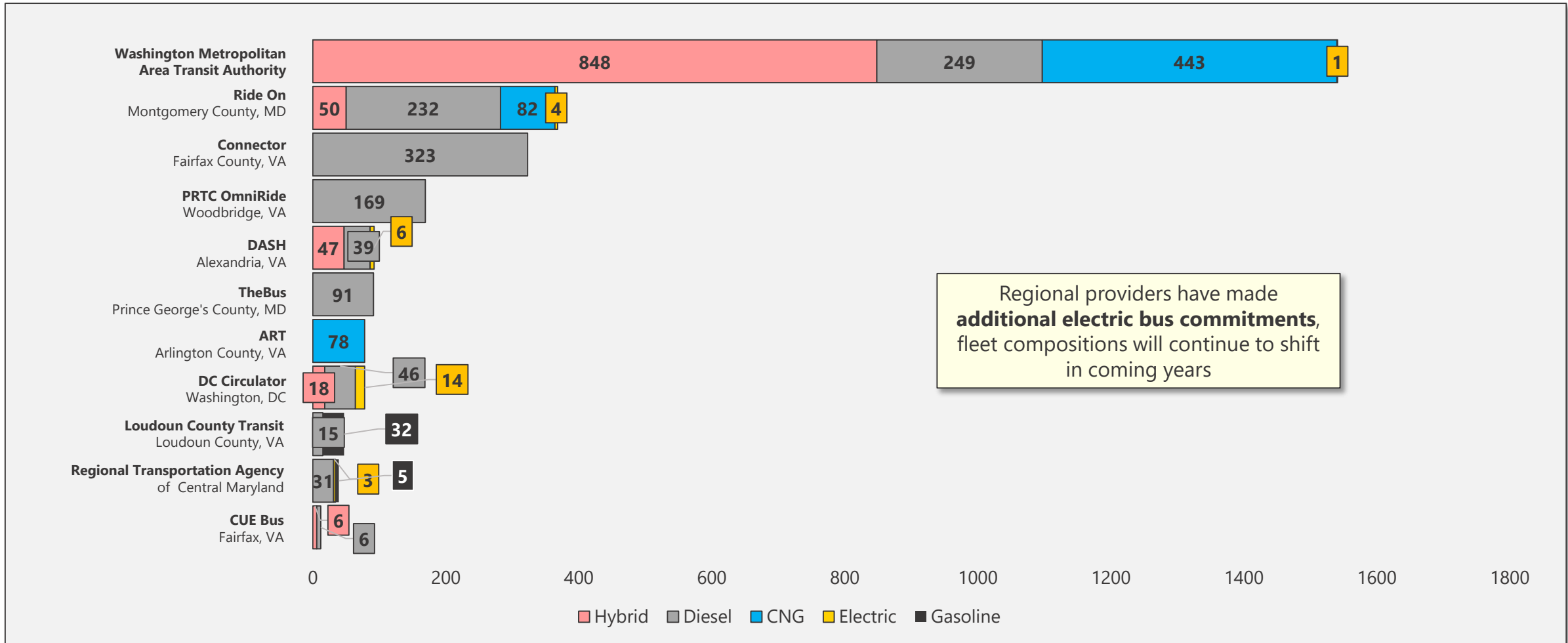
Source for US Peers: American Public Transportation Association (APTA), Public Transportation Vehicle Database

Source for Transport for London: Agency-published bus fleet data, March 2020

Data shown for most recent available data from each peer agency



# Fleet Composition, Regional Providers



Regional Provider Source: American Public Transportation Association (APTA), Public Transportation Vehicle Database  
 Figures shown for most recent available data from each peer agency, does not include commuter buses or paratransit vehicles  
 Fairfax County recently announced plans to add four electric buses to the Connector fleet



# Regional Interest in Electric Buses, Emissions, the Environment

## Highlight of comments received in Bus Transformation Project surveys and listening sessions

“**[Electric buses] produce zero emissions which is important for the health of drivers, the health of people that live along roadways, and the health of the planet.** Plus they smell better. By 2030 we should have a 100% electric fleet, or be close. Bus may beat cars any day for emissions per mile, but they still pollute and we need to be Carbon Neutral.

“...The 'greater good' benefit must be stressed, as **pollution, fossil fuel consumption**, time lost to traffic congestion must be dealt with aggressively.”

“As a bicyclist, I breathe way too much **diesel fumes** from buses, so would love to have **cleaner buses on the road.**”

“It is important that the system have **zero emission buses** - preferably electric - because our country is sleepwalking into an environmental catastrophe until we dramatically **reduce greenhouse emissions.**”

“Beyond just shifting from inefficient single occupancy vehicles, our bus system should also aspire to **reduce pollution** by switching away from high particulate emission fuels like diesel and towards **battery electric** or, less preferably, **CNG buses.**”

“I like the **electric bus on the M4.** Quiet and smooth.”

“WMATA should **move faster** than it is now [on electric buses], but not go all in until **technology and costs improve**”

“**Electric, natural gas bus fleets** must be the norm, and equipment must be maintained ...”

Of approximately 2,000 Bus Transformation Project survey comments, ~100 related to electric buses, the environment or clean air

# Washington Air Quality (2019)

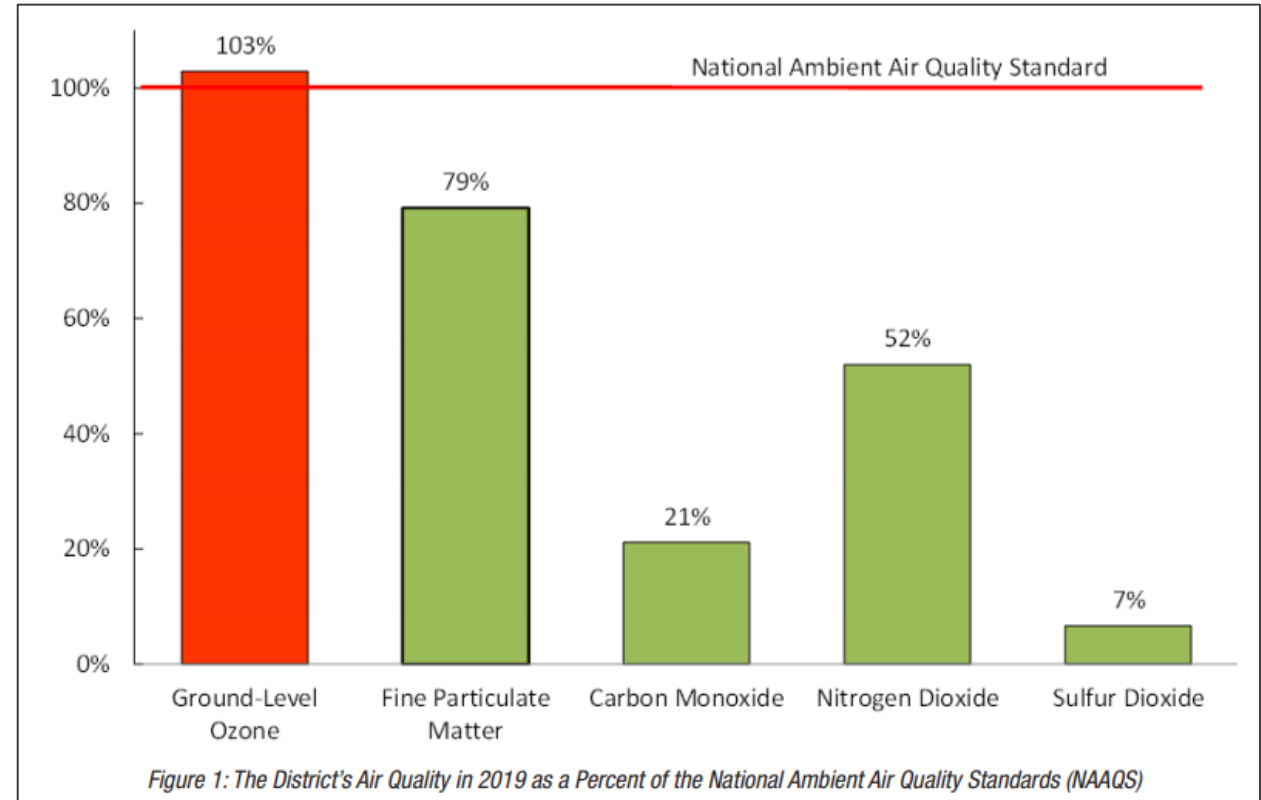


ENVIRONMENT

## Air Quality & Your Health

In metropolitan Washington, the two most important pollutants that threaten human health are ground-level ozone and particle pollution. A typical adult breathes in close to 3,500 gallons of air in a single day. If the atmosphere is polluted with ozone and particle pollution, lung function may be reduced by as much as 20 percent. Visit [Clean Air Partners](#) for health tips and to learn about ways to protect the environment.

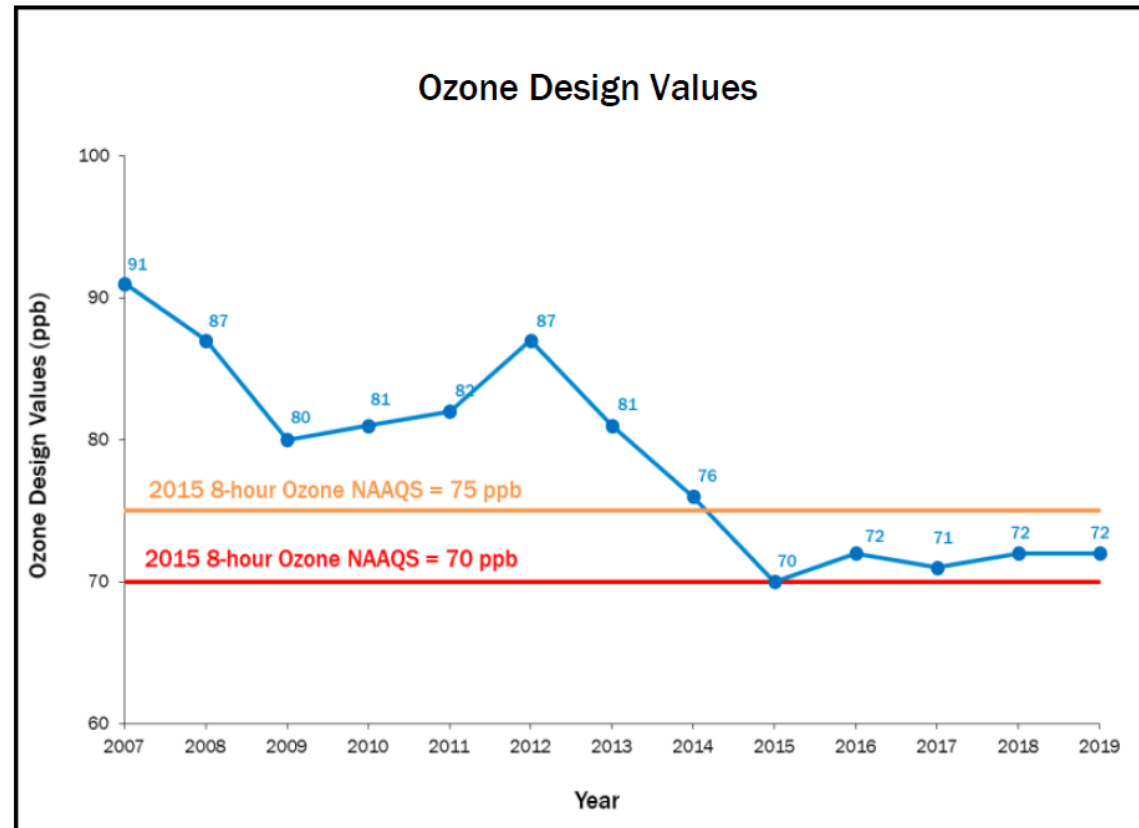
- Regional emphasis on air pollutants especially focused on ground-level ozone (NOx and VOCs) as well as particulate matter (PM2.5 and PM10), which threaten human health



Source: Washington DC Department of Energy & Environment, 2020



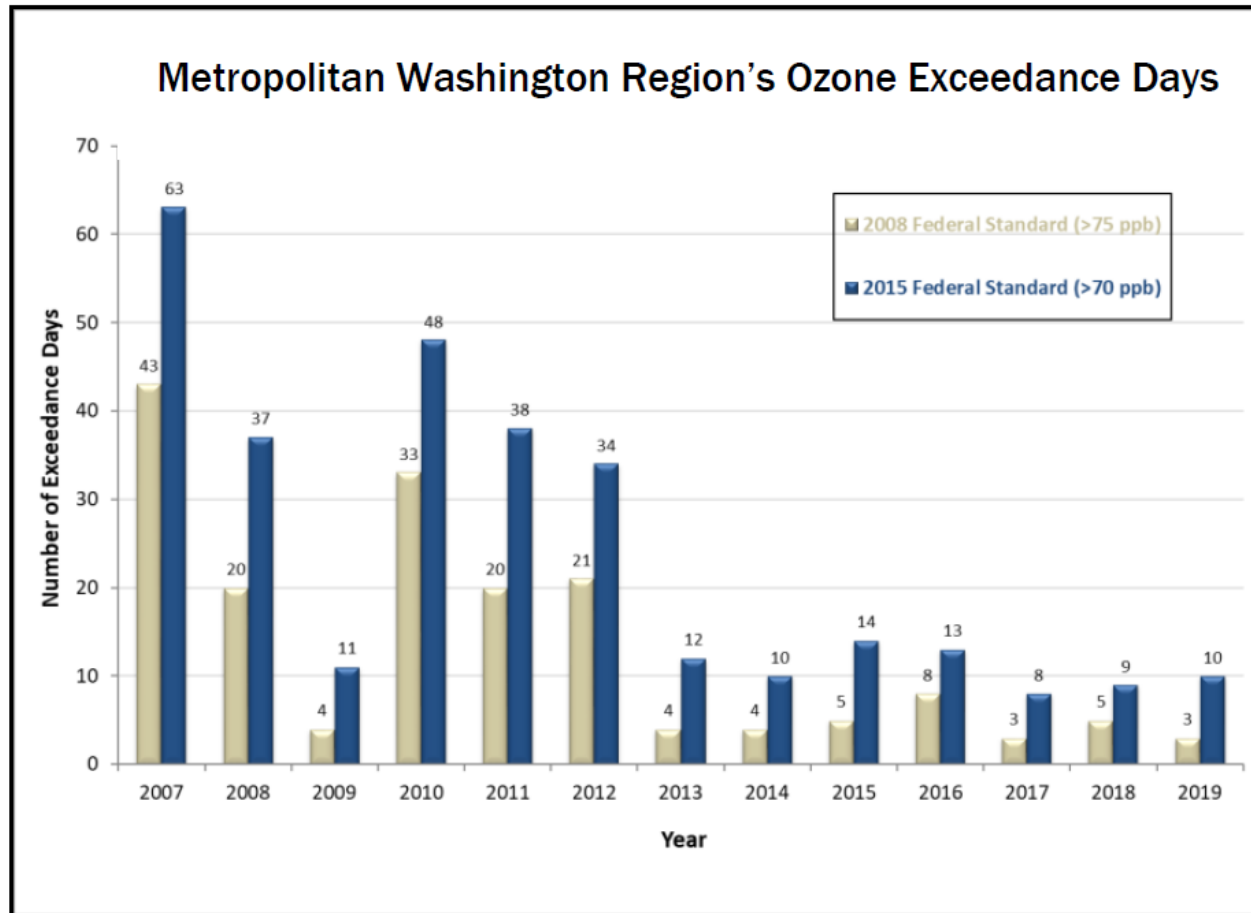
# Local Air Quality, Ozone



Design value = 3-year average of 4th highest daily maximum 8-hour average ozone concentrations

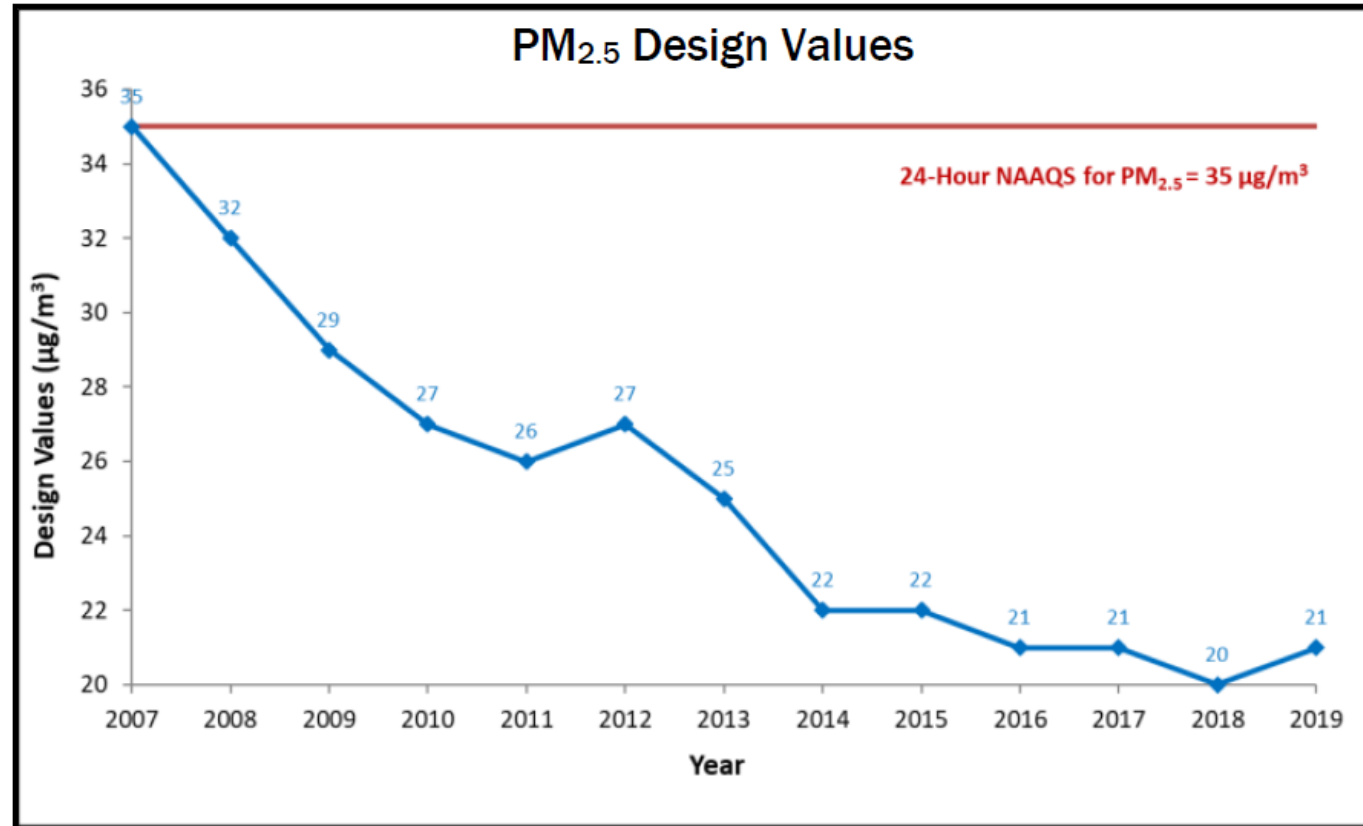
Source: Metropolitan Washington Council of Government (MWCOG), 2020

# Local Air Quality, Ozone Exceedance Days



Source: Metropolitan Washington Council of Government (MWCOG), 2020

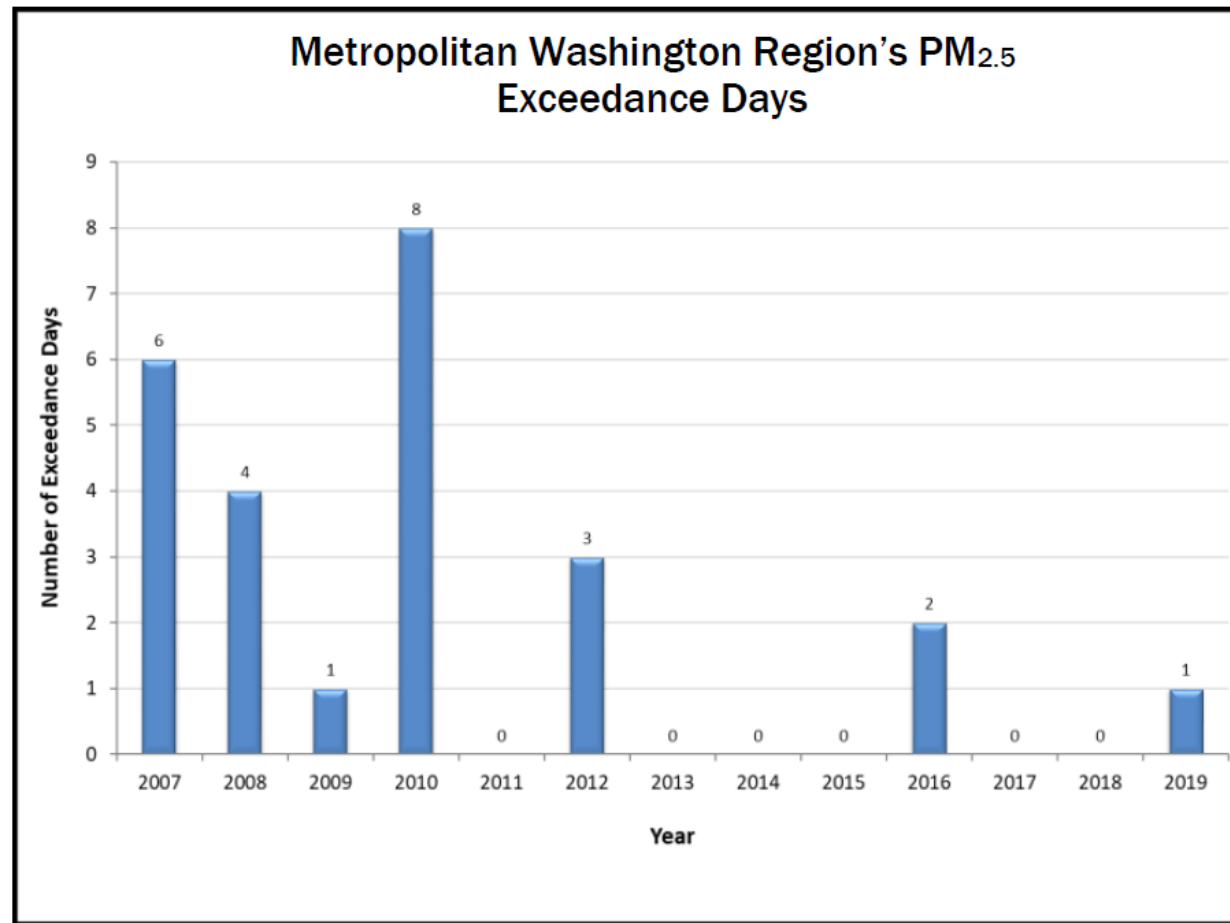
# Local Air Quality, PM<sub>2.5</sub>



The 24-hr Design Value for PM<sub>2.5</sub> is the 3-year average of the 98th percentile

Source: Metropolitan Washington Council of Government (MWCOG), 2020

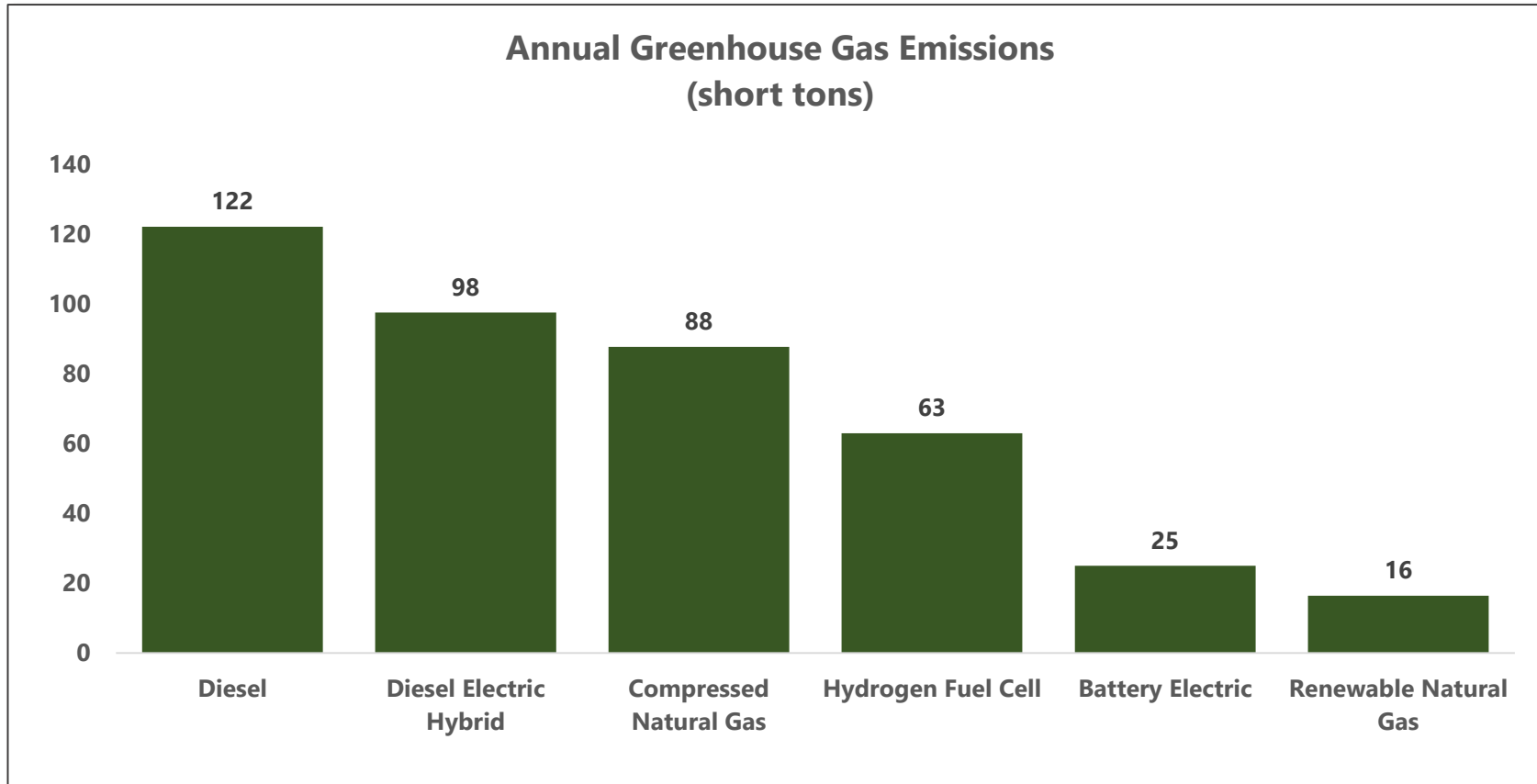
# Local Air Quality, PM<sub>2.5</sub> Exceedance Days



Source: Metropolitan Washington Council of Government (MWCOG), 2020

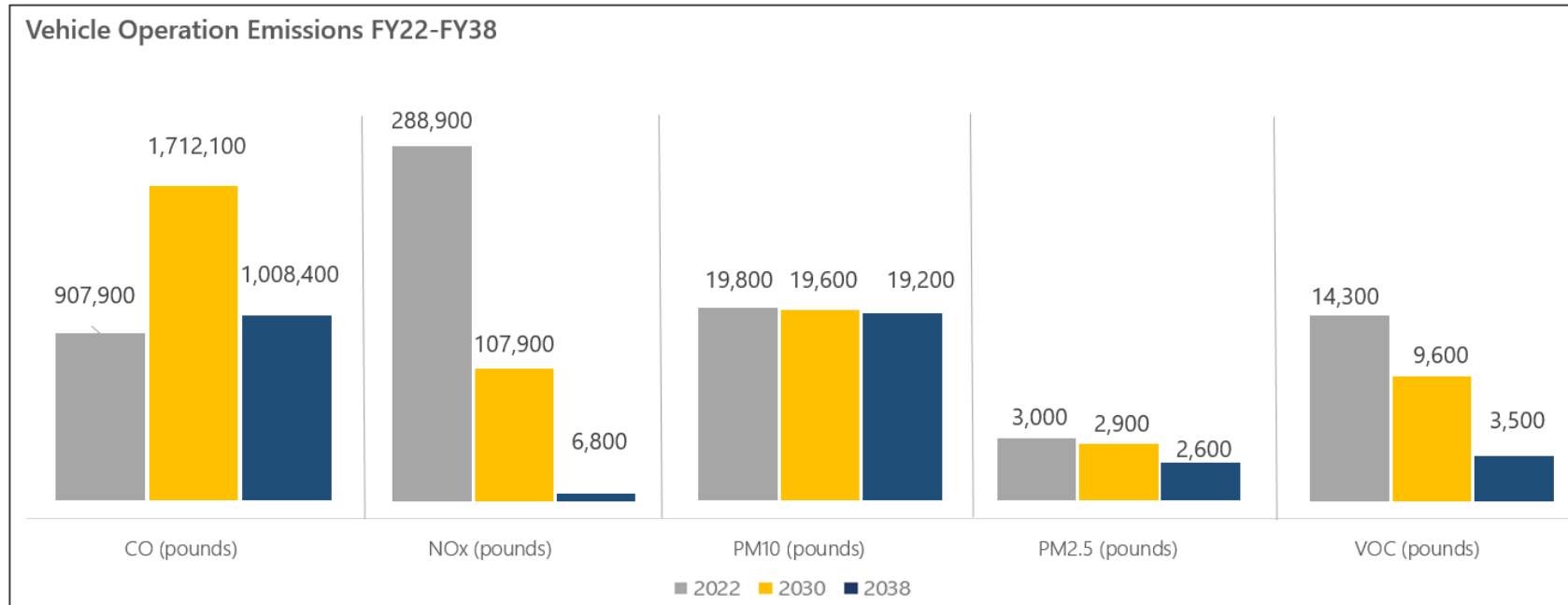


# Estimated Greenhouse Gas Emissions by Fuel Type



Source: EPA bus emissions data and 2020 Department of Energy Argonne National Laboratory model.

# Draft Strategy: Emissions Implications, Local Emissions



- **Major reduction of estimated NOx and VOC pollution levels**
- **Reduction of particulate matter (PM2.5, PM10)**
- While estimates built using US Dept. of Energy and US Environmental Protection Agency data, CO levels expected to be reduced through improved bus and mitigation technologies

Metropolitan Washington Air Quality Committee (MWACQ) and National Capital Region Transportation Planning Board (TPB) highlight concerns regarding volatile organic compounds (VOCs) and nitrogen oxides (NOx) which combine to form ground-level ozone

Source: EPA bus emissions data and 2020 Department of Energy Argonne National Laboratory model.

# Detailed Vehicle Emissions by Fuel Type

Bus Type	Clean Diesel	Diesel Electric Hybrid	Compressed Natural Gas	Renewable Compressed Natural Gas	Battery Electric	Hydrogen Fuel Cell
<b>Annual Total Greenhouse Gases</b>						
<b>Annual Total Pollutants</b>						
GHG (short tons)	122.2	97.6	87.8	16.5	25.0	63.0
CO (pounds)	186.3	102.9	1861.4	1687.4	21.1	96.4
NOx (pounds)	299.0	287.5	115.5	-11.4	35.3	161.2
PM10 (pounds)	16.0	15.3	14.0	0.4	16.3	32.5
PM2.5 (pounds)	5.1	4.5	3.2	-10.3	3.7	11.6
VOC (pounds)	28.9	25.2	31.8	-57.5	6.0	27.4
<b>Annual Vehicle Operation Pollutants</b>						
CO (pounds)	154.7	77.4	1779.6	1779.6	0.0	0.0
NOx (pounds)	239.0	239.0	12.0	12.0	0.0	0.0
PM10 (pounds)	12.1	12.1	12.1	12.1	11.7	11.7
PM2.5 (pounds)	1.9	1.9	1.9	1.9	1.5	1.5
VOC (pounds)	9.7	9.7	6.1	6.1	0.0	0.0
<b>Annual Upstream Pollutants</b>						
CO (pounds)	31.6	25.5	81.8	-92.2	21.1	96.4
NOx (pounds)	60.0	48.5	103.5	-23.3	35.3	161.2
PM10 (pounds)	3.8	3.1	1.9	-11.7	4.6	20.8
PM2.5 (pounds)	3.2	2.6	1.3	-12.2	2.2	10.1
VOC (pounds)	19.2	15.5	25.7	-63.7	6.0	27.4

1 – Assumed emphasis on landfill gas, which Washington Gas notes as the most readily available in the region. Renewable natural gas, when made from waste that would usually emit methane, has negative emission values in cases where emissions avoided from the waste's conversion to RNG outweigh any emissions that would be caused from fuel production, transportation and use in a transit vehicle.

2 – While they do not produce tailpipe emissions as conventional vehicles do, electric and hydrogen fuel cell buses, like all transit buses, generate particulate matter emissions during vehicle operation. Sources of this particulate matter include those produced by friction on brakes, tires, and road surfaces, as well as the suspension of road dust.

Source: EPA bus emissions data and 2020 Department of Energy Argonne National Laboratory model.



# Draft Strategy: Considerations, Opportunities and Risks

- **Facility support**  
Metro facilities not currently capable of supporting an expanded electric bus fleet
- **Capital costs and funding support**  
Electric buses involve additional capital costs for both vehicle purchases as well as facility improvements
- **Utility support**  
Coordination with local electric utility companies required as Metro's demands on the grid increase
- **Workforce adjustments and opportunities**  
New vehicle technologies will require new maintenance skillsets and training protocols, offer new skills and job training opportunities for workforce in the region
- **Continuity of operations**  
Diesel buses offer operational simplicity – can be parked long-term and reactivated quickly; better re-fueling options in the region if used in evacuation scenario



# Current Programmed/Planned Bus Capital Costs

- 6-Year Capital Program (FY22-FY27): **\$1.96b**
- 10-Year Capital Plan (FY22-FY31): **\$3.59b**
- Primarily State of Good Repair Rehabilitation and Replacement Programs and Projects, including:
  - Bus acquisition for lifecycle replacement
  - Bus rehabilitation
  - Bus garage replacements and rehabilitations
  - Electric bus test and evaluation program
  - Other infrastructure investments and studies



# Current Metrobus Maintenance Costs

- **Approximately ~32%** of maintenance costs related to propulsion systems, **~68% other bus components**.
- Bus maintenance costs approximately **one-quarter preventive, three-quarters corrective**.
- Propulsion maintenance includes work relating to engines, exhaust, fuel, oil, and transmission systems. Non-propulsion work includes brakes, HVAC systems, fareboxes, digital signs, doors, seats, windows, etc.
- Maintenance costs by category
  - ~70% personnel
  - ~20% materials and supplies
  - ~10% services

Share of Maintenance	Propulsion	Non-Propulsion	Total
Preventive	11%	15%	<b>26%</b>
Corrective	21%	53%	<b>74%</b>
<b>Total</b>	<b>32%</b>	<b>68%</b>	

Estimated maintenance shares of existing fleet (Hybrid, Diesel, CNG); work order data

# Metrobus Maintenance Category Examples

11%

## Preventive Maintenance, Propulsion

- Spark plug, filter replacement
- Oil changes
- Fuel tank inspections



15%

## Preventive Maintenance, Non-Propulsion

- Component servicing – digital signs, video recording systems, windshield wiper replacements, HVAC
- Interior cleaning, other scheduled maintenance



21%

## Corrective Maintenance, Propulsion

- Engine repairs, leaks
- Oil contamination
- Exhaust fumes and leaks
- Transmission and gear shifting issues



53%

## Corrective Maintenance, Non-Propulsion

- Component repairs – doors, seats, windows, farebox systems, digital signs, HVAC, wheelchair ramps, flat and worn tires
- Collision damage



# Current Metrobus Maintenance Costs by Category

## Propulsion-related maintenance work, additional detail

Share of Maintenance	Propulsion	Non-Propulsion	Total
<b>Preventive</b>	<b>11%</b>	<b>15%</b>	<b>26%</b>
Engine	2%	-	2%
Exhaust	8%	-	8%
Fuel	1%	-	1%
Oil	0%	-	0%
Transmission	0%	-	0%
Brakes	-	0%	0%
Other	-	15%	15%
<b>Corrective</b>	<b>21%</b>	<b>53%</b>	<b>74%</b>
Engine	13%	-	13%
Exhaust	3%	-	3%
Fuel	2%	-	2%
Oil	1%	-	1%
Transmission	2%	-	2%
Brakes	-	6%	6%
Other	-	47%	47%
<b>Total</b>	<b>32%</b>	<b>68%</b>	

Sub-categories of propulsion-related maintenance work

Other types of maintenance include work related to the HVAC system, interior cleaning, windows, doors, seats, fareboxes, digital signs, wheelchair ramps, tires, and more.

Regenerative braking in electric buses may lead to reduced maintenance costs in the future.

Hybrid vehicles in Metro's fleet, which have regenerative brakes, require about 30% less brake-related maintenance than Diesel and CNG buses.

Heavier vehicle weight leads to increased brake wear. Electric vehicle weight, which is typically higher than conventional buses, may impact brake maintenance costs.



# Order of Magnitude Maintenance and Fuel Cost Comparison Electric Bus against Fleet Average Baseline<sup>1</sup> Potential for Significant Savings Long-Term

	Current	Estimated at Maturity
<b>Combined Electric Bus Maintenance and Fuel Costs</b>	<b>~1% increase</b>	<b>~18-25% reduction</b>
Maintenance	~13% increase	~10-20% reduction
Fuel	~40% reduction	~40% reduction

<sup>1</sup> Metro's current fleet is approximately 55% Hybrid, 30% CNG, 15% Diesel, and <1% electric.

- Potential long-term reduced maintenance costs in bus propulsion and brakes:
  - **Engine:** internal combustion engine replaced by electric motor
  - **Exhaust:** system not a feature of electric vehicles
  - **Fuel:** system not a feature of electric vehicles
  - **Oil:** need for combustion engine and transmission oil eliminated
  - **Transmission:** simplified transmission without clutch mechanism
  - **Brakes:** reduced wear from regenerative braking, higher vehicle weight may limit savings
- Other components unique to electric bus expected to add to maintenance costs, e.g., battery packs, software and technology systems, charging equipment on-board the bus.
- **Higher maintenance costs expected in short-term for electric buses.** Maintenance cost reductions will not be immediate, expected to be realized over time as fleet composition shifts and electric bus technology matures.
- Based on preliminary analysis of current maintenance cost categories, electric buses at maturity may realize significant savings, **estimated ~10-20% reduction in maintenance costs per bus compared to conventional vehicles.** Estimates remain uncertain as agencies add experience with new technology.

SUBJECT: ADOPTION OF A SUSTAINABILITY VISION AND PRINCIPLES AND ZERO EMISSION VEHICLE GOALS

RESOLUTION  
OF THE  
BOARD OF DIRECTORS  
OF THE  
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

WHEREAS, Pursuant to Compact § 9(b), and Bylaws, Article II.1, the Board of Directors is primarily responsible for policy, financial direction, oversight, and WMATA's relationships with its customers, jurisdictional partners, and signatories; and

WHEREAS, WMATA has a long-standing commitment to enhancing the sustainability of the Washington Metropolitan Area; and

WHEREAS, Adopting a sustainability vision and principles will set direction and pillars for sustainability, which WMATA will implement through capital investments, operational planning, and strategic engagement throughout the region; and

WHEREAS, Adopting zero emission vehicle goals will enable WMATA to advance an updated Metrobus Fleet Plan and make purchasing decisions to transition to a zero emissions bus fleet;

NOW, THEREFORE, be it

*RESOLVED*, That the Board of Directors adopts the Sustainability Vision and Principles included as Attachment A to this resolution; and be it further

*RESOLVED*, That the Board of Directors establishes the following goals: (1) purchase only lower-emission and electric buses in the next bus procurement; (2) transition to 100% zero emission bus purchases by 2030; and (3) transition to 100% zero emission bus fleet by 2045; and be it further

*RESOLVED*, That this Resolution shall be effective 30 days after its adoption in accordance with Compact § 8(b).

Reviewed as to form and legal sufficiency,

/s/ Patricia Y. Lee  
Patricia Y. Lee  
Executive Vice-President and General Counsel

WMATA File Structure No.:  
6.6.7. Bus Fleet Planning & Acquisition

PROPOSED

## **ATTACHMENT A**

### **Sustainability Vision and Guiding Principles**

#### **Vision**

WMATA provides a sustainable transportation system that meets the needs of people, communities, and businesses in the region, and fosters social wellbeing, equity, economic prosperity, and environmental stewardship.

#### **Guiding Principles**

1. Develop and implement an action plan with specific priorities, strategies, and targets to advance sustainability at WMATA and in the region
2. Recognize that our investments and operational decisions change lives. Make those decisions intentionally to address historical, social, environmental, and economic disparities and racial and social injustice
3. Build, operate, and maintain a resilient transportation system to improve livability, the environment, public health, equity, and access to opportunity
4. Leverage the special nature of WMATA's service and our unique market position to advance regional goals
5. Make cost-effective and data-driven business decisions that provide WMATA and its partners with the best return on their investment
6. Advance the region's efforts by leading transparent and authentic collaboration with stakeholders and community partners
7. Foster a culture of continuous improvement by growing staff capacity and leveraging regional expertise and innovation
8. Establish measurable performance indicators to track implementation and successes of WMATA's strategies and actions