TPB Technical Committee: October 2, 2020

Item #4: TPB Work Session on Climate Change Planning in the National Capital Region (October 21, 2020)

Attachment: Materials from the Climate Energy and Environment Policy Committee (CEEPC) Meeting held on September 23, 2020

- DRAFT RESOLUTION OF THE BOARD OF DIRECTORS OF THE METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS REGARDING CLIMATE MITIGATION AND RESILIENCE GOALS

- OVERVIEW OF DRAFT METROPOLITAN WASHINGTON 2030 CLIMATE AND ENERGY ACTION PLAN

- METROPOLITAN WASHINGTON 2030 CLIMATE AND ENERGY ACTION PLAN – DRAFT

- METROPOLITAN WASHINGTON 2030 CLIMATE AND ENERGY ACTION PLAN – DRAFT - APPENDICES

DRAFT **Resolution Rxx-2020**
October 14, 2020

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS
777 NORTH CAPITOL STREET, NE
WASHINGTON, DC 20002

RESOLUTION OF THE BOARD OF DIRECTORS OF THE METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS REGARDING CLIMATE MITIGATION AND RESILIENCE GOALS

WHEREAS, in 2019, the Intergovernmental Panel on Climate Change updated its guidance to recognize that the world is already experiencing the impacts of global warming and to avoid most severe climate impacts greenhouse gas emissions must fall by at least 45 percent from 2010 levels by 2030 and to carbon neutrality by 2050; and

WHEREAS, an overarching Region Forward sustainability goal is to seek a significant decrease in greenhouse gas emissions, with substantial reductions from the built environment and transportation sector; and

WHEREAS, the Board of Directors in Resolution R60-08 adopted the National Capital Region Climate Change Report and its recommendations in 2008, including goals to reduce greenhouse gas emissions by 10% below business as usual by 2012, 20% below the region's 2005 baseline by 2020, and 80% below the 2005 baseline by 2050;

WHEREAS, the Board of Directors in Resolution R18-09 established the Climate, Energy and Environment Policy Committee (CEEPC) in 2009 to collaboratively work toward the report's goals; and

WHEREAS, COG and its members were recognized by the Global Covenant of Mayors for Climate and Energy (GCoM) in 2019 as a U.S. Metro-Scale Climate Leader and CEEPC became a GCoM Signatory committing to follow global best practices in climate planning; and

WHEREAS, CEEPC has reviewed the updated IPCC guidance and GCoM protocols and recommends COG establish an interim 2030 climate mitigation goal of 50 percent greenhouse gas reduction below 2005 and climate resilience goals of becoming a Climate Ready Region by 2030 and fully Resilient Region by 2050; and

WHEREAS, CEEPC recognizes that strong actions are needed to avoid the most severe climate impacts and is developing a 2030 Climate and Energy Action Plan to include recommended actions to meet the region's climate mitigation and resiliency goals; and

WHEREAS, the Board of Directors in Resolution R26-2020 affirmed that equity will be woven into COG's programs and priorities.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS THAT:

1) The Board endorses an interim climate mitigation goal of 50 percent greenhouse gas emission reductions below 2005 levels by 2030; and

2) The Board endorses climate resilience goals of becoming a Climate Ready Region and making significant progress to be a Climate Resilient Region by 2030; and

3) The Board reinforces the need to incorporate equity principles into CEEPC and COG members' actions to reach the climate mitigation and resiliency goals; and

4) The Board directs CEEPC to report back a mid-point evaluation of the progress towards the climate mitigation and resiliency goals and make recommendations for any new actions needed.

OVERVIEW OF DRAFT METROPOLITAN WASHINGTON 2030 CLIMATE AND ENERGY ACTION PLAN

Maia Davis, COG Environmental Programs

Climate, Energy and Environment Policy Committee

September 23, 2020

Metropolitan Washington
Council of Governments

COG Region Forward Goal Areas

- Climate and Energy
- Economy
- Environment
- Health and Human Services
- Transportation
- Education
- Land Use
- Public Safety
- Housing
- Equity

CEEPC Guiding Principles

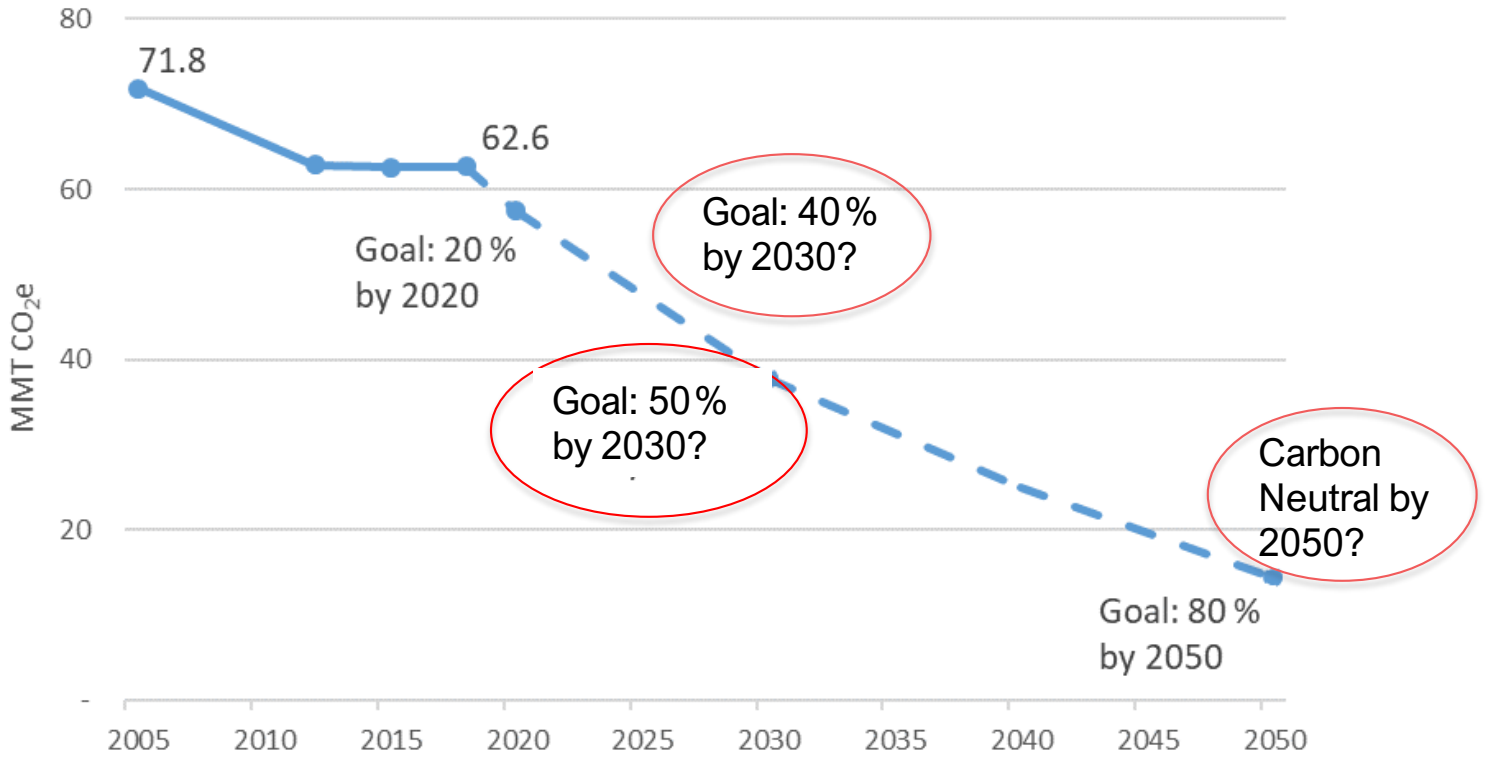
Principle	Description
1. Collective Action	We will continue to work together to leverage our impact and facilitate application at scale.
2. Effective Partnerships	We will continue to share best practices, learn together, and coordinate on implementation to advance regional transformation.
3. Lead by Example	We have a continued commitment to internal implementation of long-term solutions to reduce the climate impacts of our operations.
4. Integration	We understand climate action is inherently multidisciplinary and will promote cross-department coordination, including in areas such as equity, health, and economic development.
5. Flexibility	We understand the need for flexibility in how our public agencies and stakeholders across the DC, MD, and VA work to achieve regional GHG goals.
6. Transparency	We will continue to measure and report progress in a manner easily understandable by all.
7. Innovation	We support a just transition to a clean energy economy through the application of innovative technology, policies, and processes by public and private sectors.
8. Community Leadership	We will continue to educate, motivate, and empower action from our community's institutions, businesses, non-profits, and residents.
9. Inclusive Engagement	We commit to inclusive community engagement and equitable provision of climate and energy programs and services.
10. Advocacy	We will continue to support state and federal policies and programs that protect the human and environment health of our communities.

Four Main Plan Elements

Element	Description
1. Greenhouse Gases	Summary of regional GHG inventory trends from 2005 – 2018, business-as-usual (BAU) GHG emission projections through 2030, and technical scenario showing what it will take for the region to reach GHG reductions of 50% below 2005 levels by 2030.
2. Climate Mitigation Strategy	CEEPC's priority collaborative mitigation actions to move the region toward achieving the GHG emission reduction goal of 50% by 2030, below 2005 levels. Climate action areas include Planning, Equity, Clean Electricity, Zero Energy Buildings, Zero Emission Vehicles, Zero Waste, and Sequestration.
3. Climate Risks and Vulnerabilities	Summary of the Regional Climate, Risk and Vulnerability Assessment (CRVA). Evaluates climate hazards: extreme heat, drought, lightning and thunderstorms, flash and riverine flooding, coastal flooding and extreme winter conditions.
4. Climate Resilience Strategy	CEEPC's priority collaborative climate resilience actions to move the region toward achieving the goal of becoming a Climate-Ready Region 2030. The action areas include Planning, Equity, and Resilient Infrastructure.

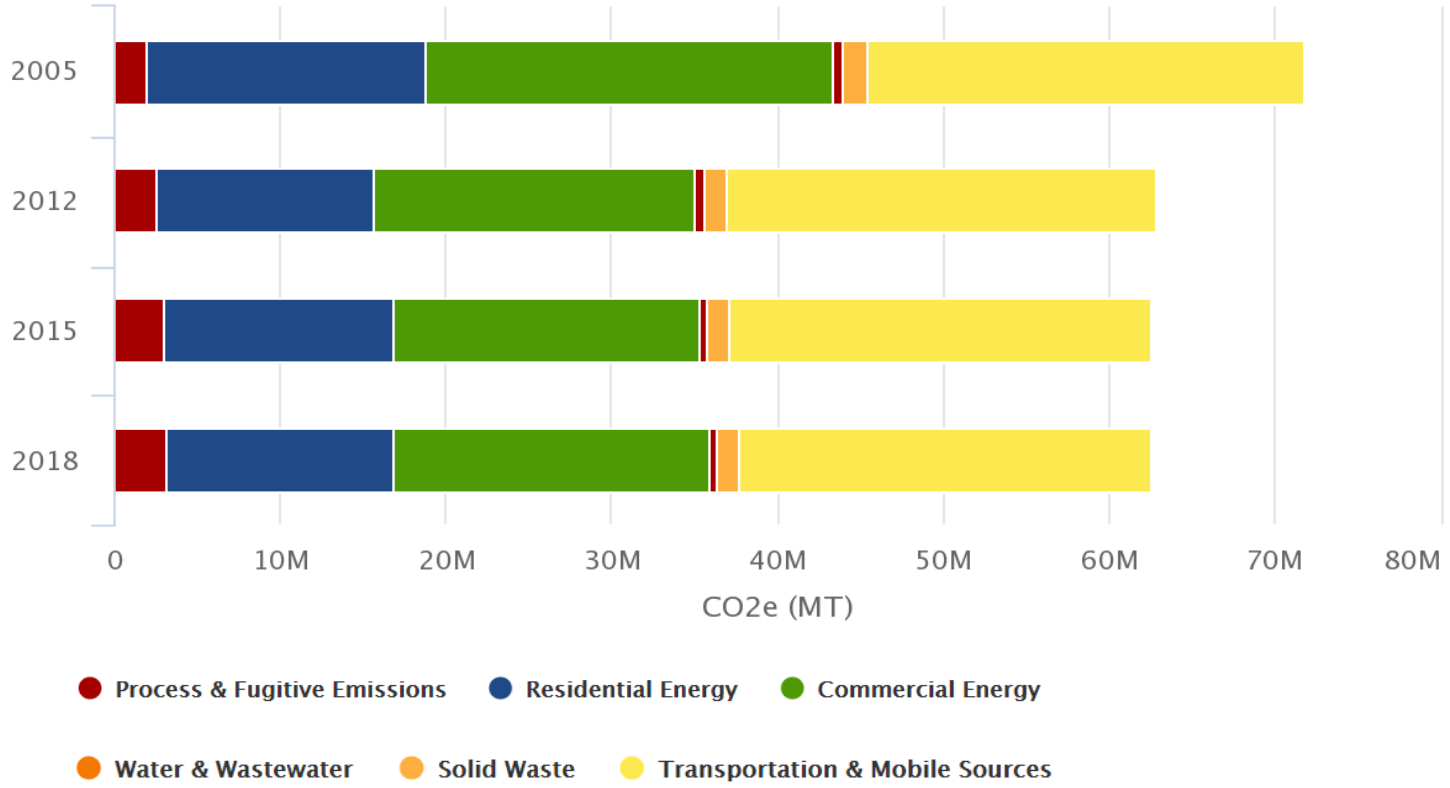
Updated Regional GHG Mitigation Goals

- 40 to 50% 2030 GHG reduction goal?
- Carbon neutral by 2050 goal?



Regional GHG Mitigation Goals

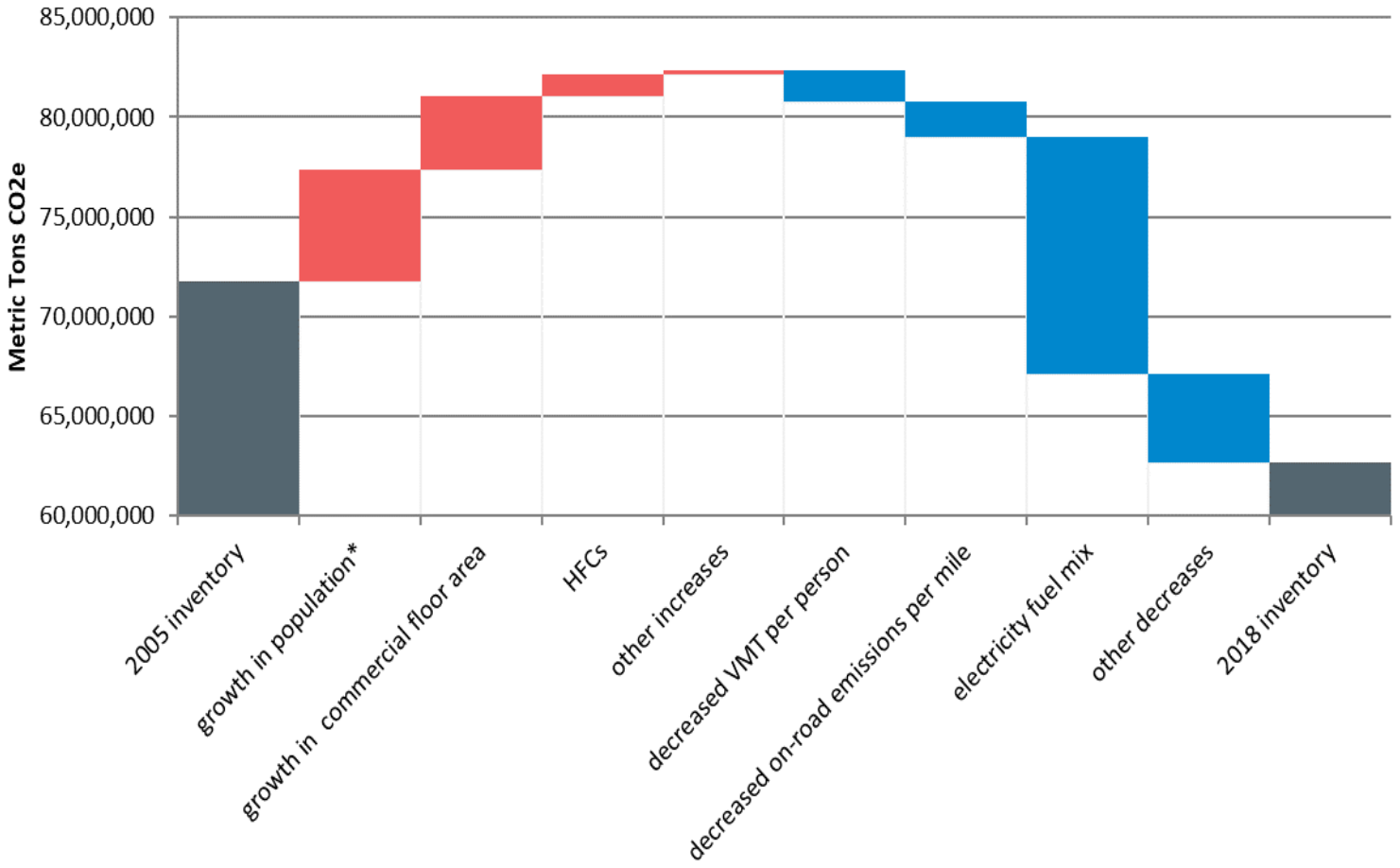
- 13% Reduction in GHGs across region, 2005 - 2018



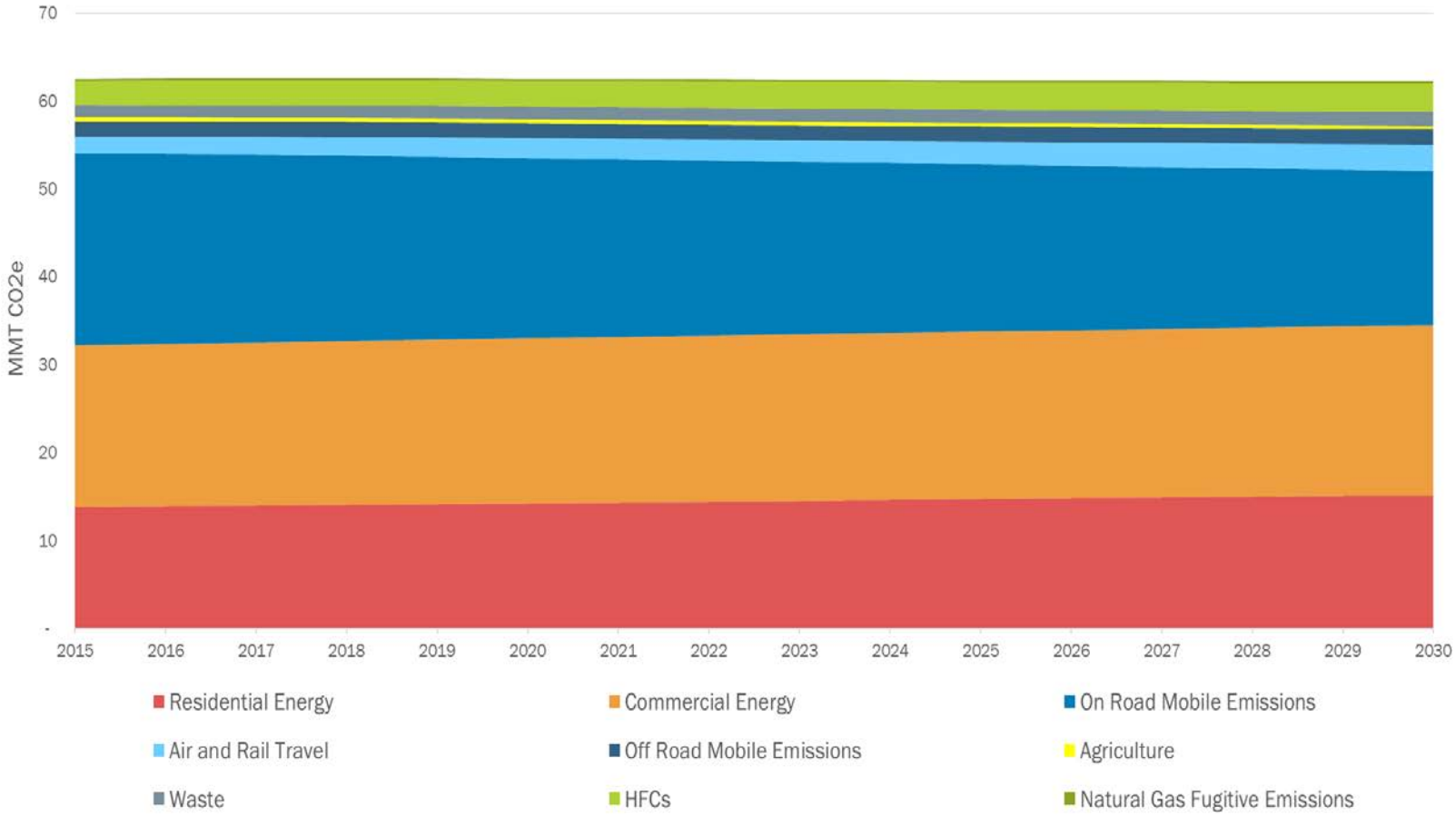
Source: ClearPath output

Note: ClearPath is an online greenhouse gas inventory tool. ClearPath is a product of ICLEI - Local Governments for Sustainability.

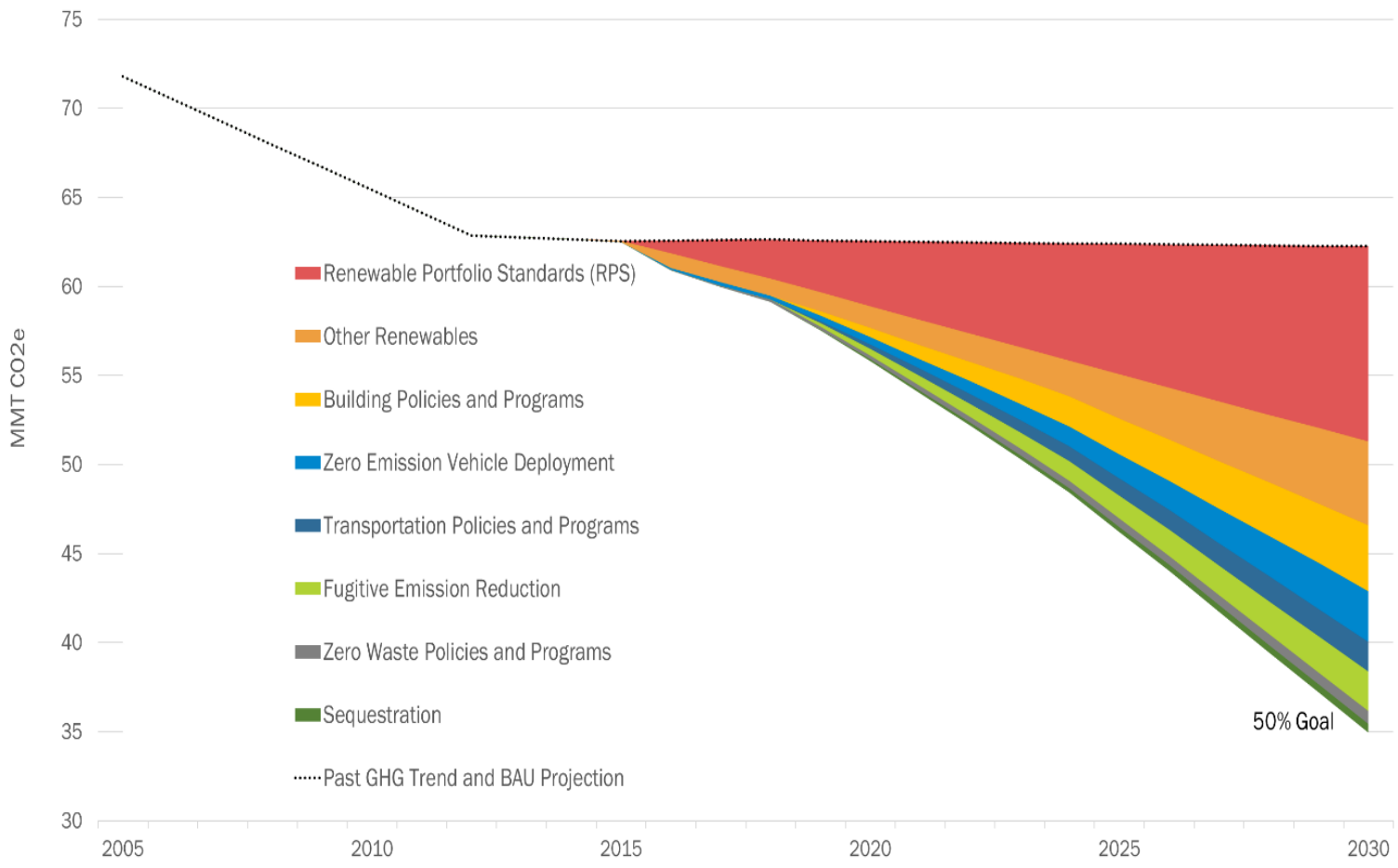
Drivers of Regional GHG Change



Business As Usual Emissions



2030 Scenario



50% Reduction – Technical Potential

GHG Emission Reduction Activity	Assumptions
Renewable Portfolio Standards	Current standards (DC 87%, MD 50%, Northern VA 38% by 2030)
Other Renewables	> 200,000 additional solar systems, equivalent to 24% of single-family homes
	Continued 10% annual growth of green power purchases
	>16% of gas supply from renewable natural gas
Building Policies and Programs	All new construction net zero energy by 2030
	2% of residential and commercial existing buildings get deep retrofits annually
Zero Emission Vehicle Deployment	EV adoption rates of >20% light duty cars, >9% light duty trucks, >4% medium/heavy duty trucks, and >30% transit buses.
Transportation Policies and Programs	75% new housing in Activity Centers with high capacity transit.
	Continued transit improvements and transportation demand management to reduce VMT
Zero Waste Policies and Programs	80% diversion by 2030

Mitigation Actions

Climate Action Area	Action ID	Priority Collaborative Action
Planning	PL - 1	Advance Climate Planning and Track Progress
Equity	EQ - 1	Enable Equitable Planning Practices
	EQ - 2	Prioritize Sustainable Energy Access for All
Clean Electricity	CE - 1	Advocate for Aggressive Renewable Portfolio Standards
	CE - 2	Accelerate Development of On-Site Renewables
	CE - 3	Accelerate Deployment of Battery Storage
	CE - 4	Accelerate Development of Microgrids for Critical Infrastructure
	CE - 5	Accelerate Development of Large-Scale Off-Site Renewables
	CE - 6	Advocate for and Implement Community Choice Aggregation
Zero Energy Buildings	ZEB - 1	Expand Building Benchmarking Requirements
	ZEB - 2	Accelerate Deep Building Retrofits
	ZEB - 3	Enhance Green Building Codes and Policies to Facilitate Net Zero Energy Building Development
	ZEB - 4	Expand Proper Disposal and Leak Detection of Refrigerants

Mitigation Actions (continued)

Climate Action Area	Action ID	Priority Collaborative Action
Zero Emission Vehicles	ZEV - 1	Expand Light-Duty Electric Vehicle Deployment
	ZEV - 2	Accelerate Electrification of Medium- and Heavy-Duty Vehicles
	ZEV - 3	Build Out Regional Electric Vehicle Charging Network
Zero Waste	ZW - 1	Implement Curbside Organics Recycling Programs
	ZW - 2	Reduce Solid Waste Generation
	ZW - 3	Build Markets for Circularity
Sequestration	SQ - 1	Strategically Plant New Trees on Publicly Owned Land
	SQ - 2	Enhance Regulatory Capacity to Manage Tree Canopy and Forest Protection
	SQ - 3	Enhance Tree Planting and Preservation on Privately Owned Lands

Action Components

Title

Action Description

Local, Regional, or State Example

How it supports GHG reduction and what level of implementation is needed to meet 50% by 2030

How COG Can Support Implementation

How Local Jurisdictions Can Support Implementation

Region Forward Co-Benefits

ZEB-3: ENCHANCE GREEN BUILDING CODES AND POLICIES TO FACILITATE NET ZERO BUILDING DEVELOPMENT

Action Overview

Green building codes are laws established by states or local jurisdictions applying to newly constructed buildings or major renovations that mandate increased levels of energy efficiency and often include a requirement for the inclusion of on-site renewable energy systems. Green building codes can help to accelerate the adoption of net zero buildings – those that produce as much energy as they use - across the region.

Maryland, Virginia, and the District of Columbia have all adopted building codes that incorporate energy efficiency components outlined in the International Energy Conservation Code (IECC) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) standards. While local jurisdictions in Maryland are permitted to pass more stringent codes that exceed state minimum standards ("stretch codes"), local jurisdictions in Virginia are not. Member jurisdictions in Maryland, including Montgomery County and City of Rockville, have a history of adopting codes that are more stringent than those required by the state. Currently, Montgomery County is in the process of adopting the 2018 International Green Construction Code (IGCC).

Supporting Overall GHG Reduction Goal

Adopting more stringent building codes, both at the state and local level, can be effective in significantly reducing the total energy consumption and increasing the level of on-site renewable energy generation of commercial, municipal, and residential buildings. Since half of all GHG emissions in the region are associated with the built environment, green building codes have significant potential to reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:
All jurisdictions will need to implement building codes that require net zero energy standards in new construction by 2030, through either adoption of local stretch codes or compliance with potential future state requirements that

How COG Can Support

- Convene technical experts and facilitate information exchange that enable creation of policies and programs and address barriers to action.
- Coordinate local government input to the national model energy code development process.
- Encourage adoption of building codes and incentives to facilitate net zero building construction.

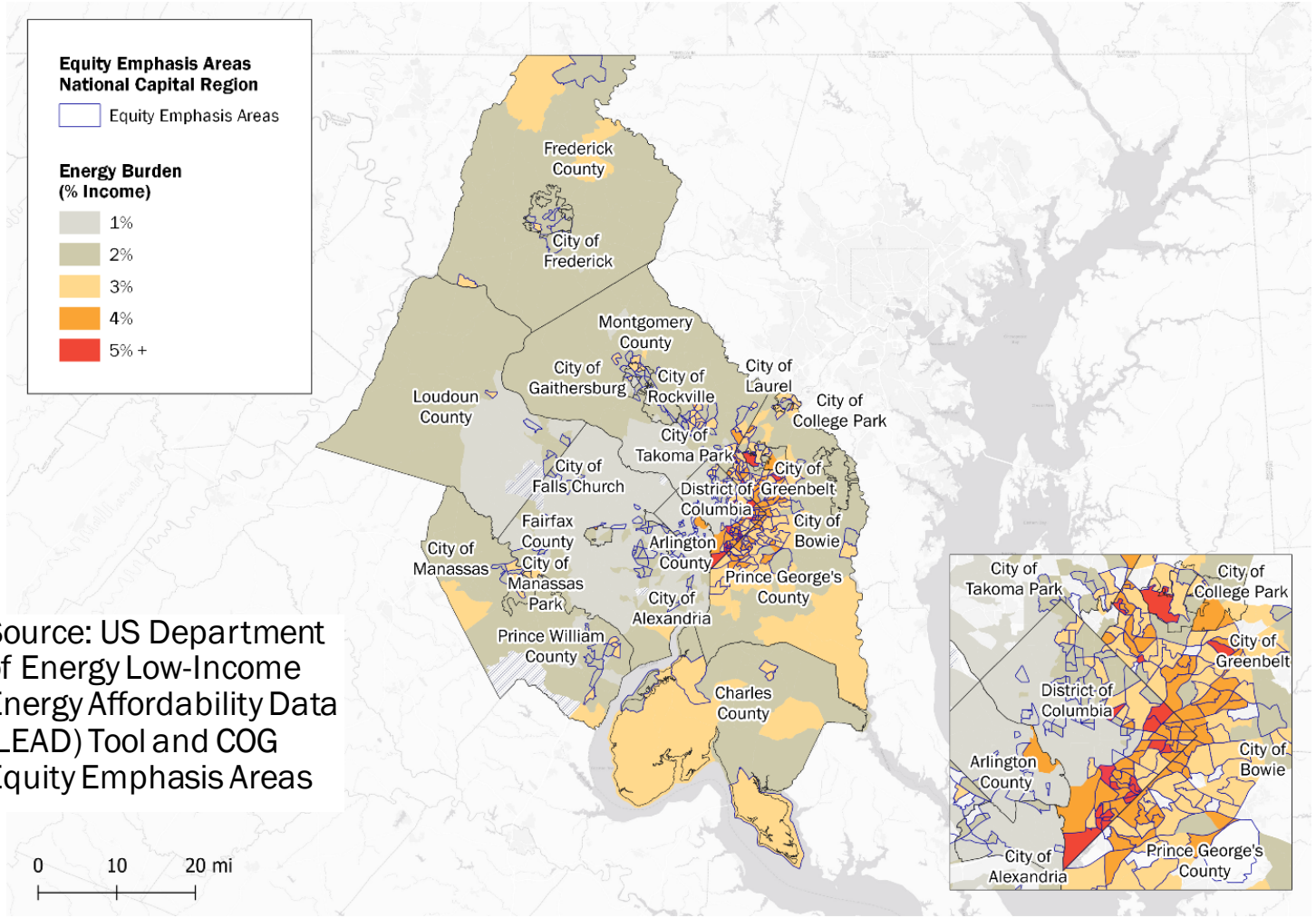
How Member Jurisdictions Can Support

- Participate in the national energy code development process.
- Adopt policy for all new local public facilities to be net zero energy.
- Adopt net zero energy codes or incentives for private development.
- Include net zero energy goals and strategies in master, comprehensive, and small area plans.
- Establish a net zero energy building district or portfolio.
- Provide education and training on new and advanced green construction standards.

Region Forward Co-Benefits:

- **Environment**: Building codes can be designed to address both energy and water efficiency.
- **Health and Human Services**: Green buildings with enhanced ventilation help to increase indoor air quality, reduce illness, and improve productivity.
- **Public Safety**: As net zero building codes continue to deemphasize reliance on natural gas in new construction, the risks associated with natural gas leaks and explosions will decrease.

Equity Emphasis Areas and Energy Burden



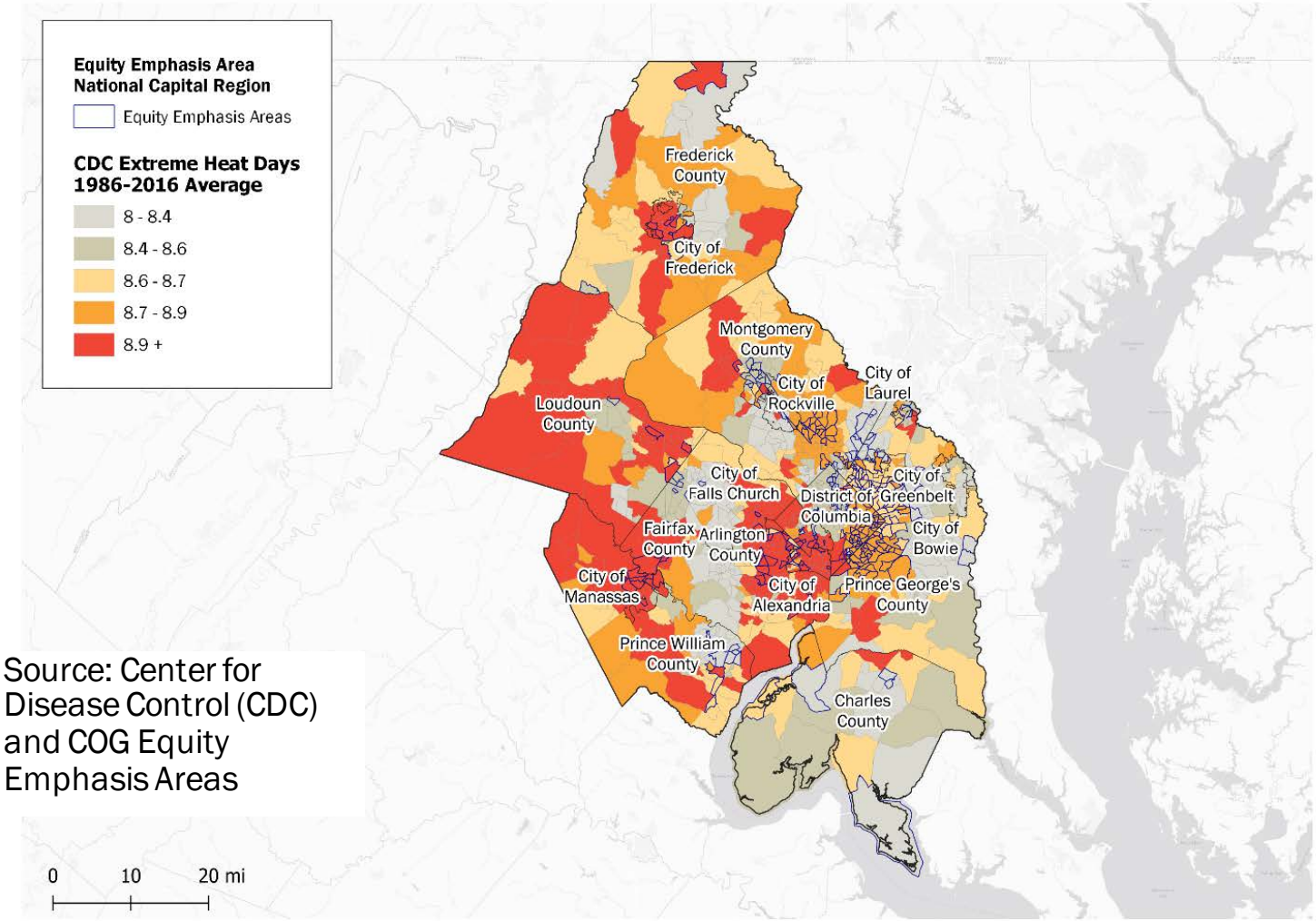
Source: US Department of Energy Low-Income Energy Affordability Data (LEAD) Tool and COG Equity Emphasis Areas

Risk Levels and Adaptive Capacity Degree of Challenge

Hazard	Probability	Consequence	Risk
Extreme Heat	3	3	9
Drought	2	3	6
Flooding (Flash and Riverine)	3	3	9
Coastal Flooding	3	2	6
Lightning/Thunderstorm	3	2	6
Extreme Winter Conditions	2	3	6

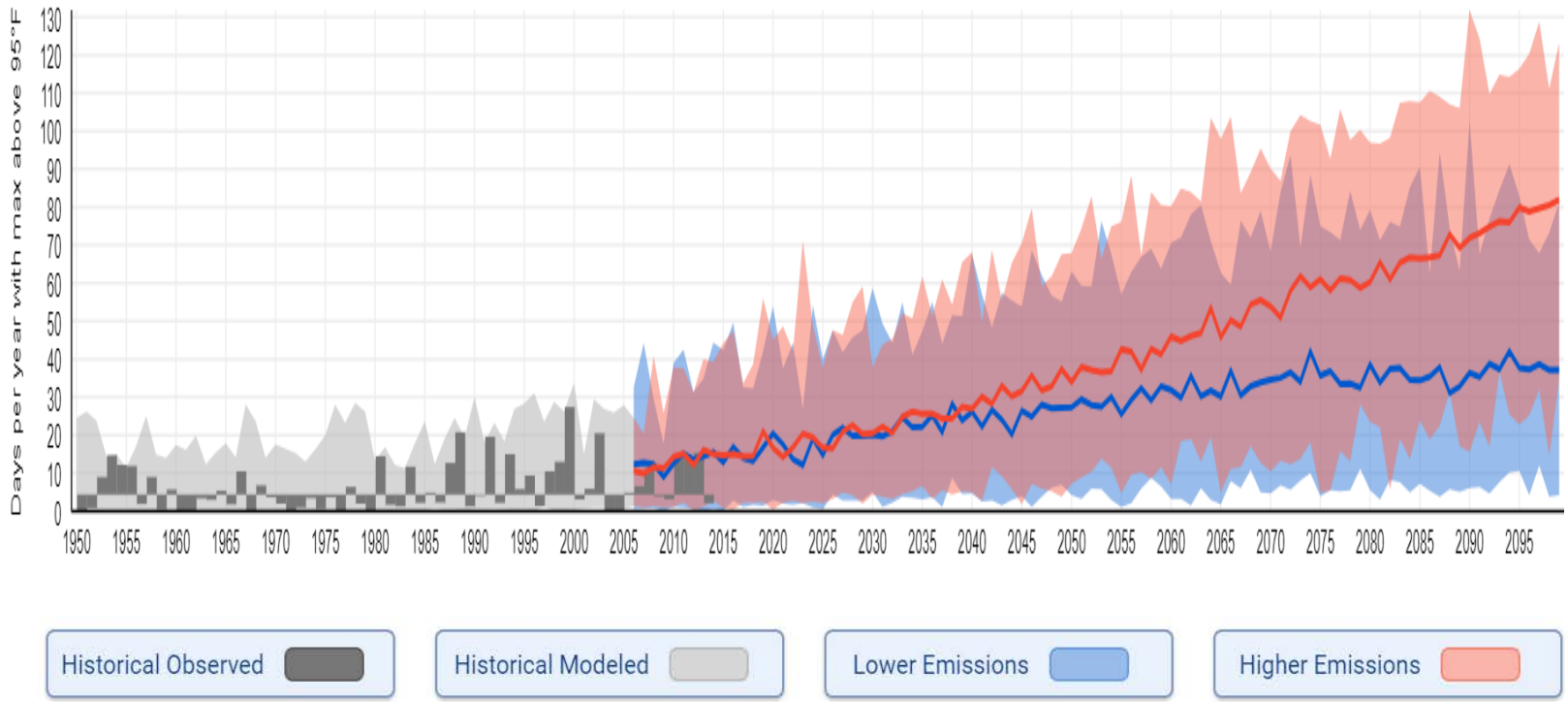
Factor	Degree of Challenge
Infrastructure Conditions/Maintenance	High
Access to Basic Services	Moderate
Access to Healthcare	Moderate
Public Health	Moderate
Housing	Moderate
Poverty	Moderate
Community Engagement	Moderate
Environmental Conditions	Moderate
Economic Health	Low

Equity Emphasis Areas and Extreme Heat



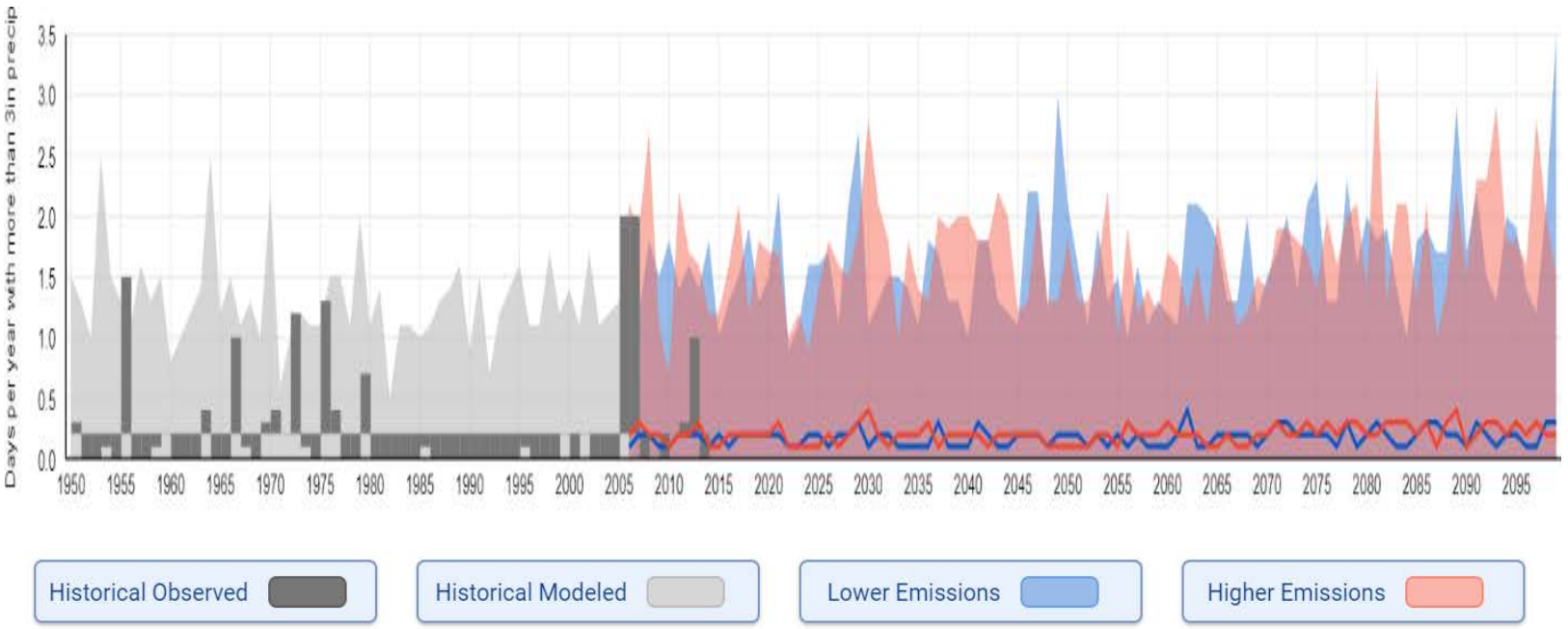
Source: Center for Disease Control (CDC) and COG Equity Emphasis Areas

Days Over 95°F from 1950 until 2095



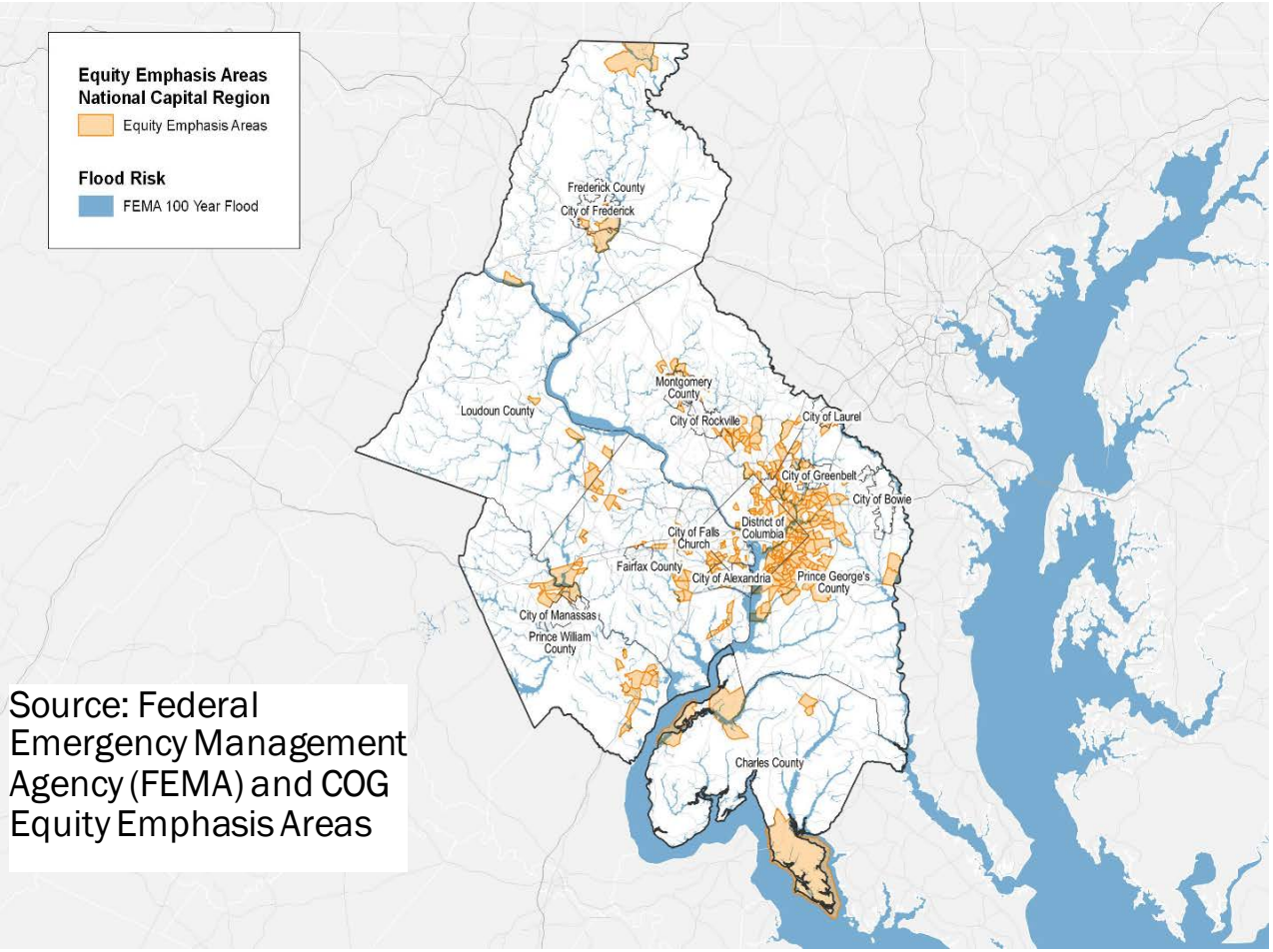
Source: NOAA Climate Explorer

Days Per Year with >3 Inches Precipitation



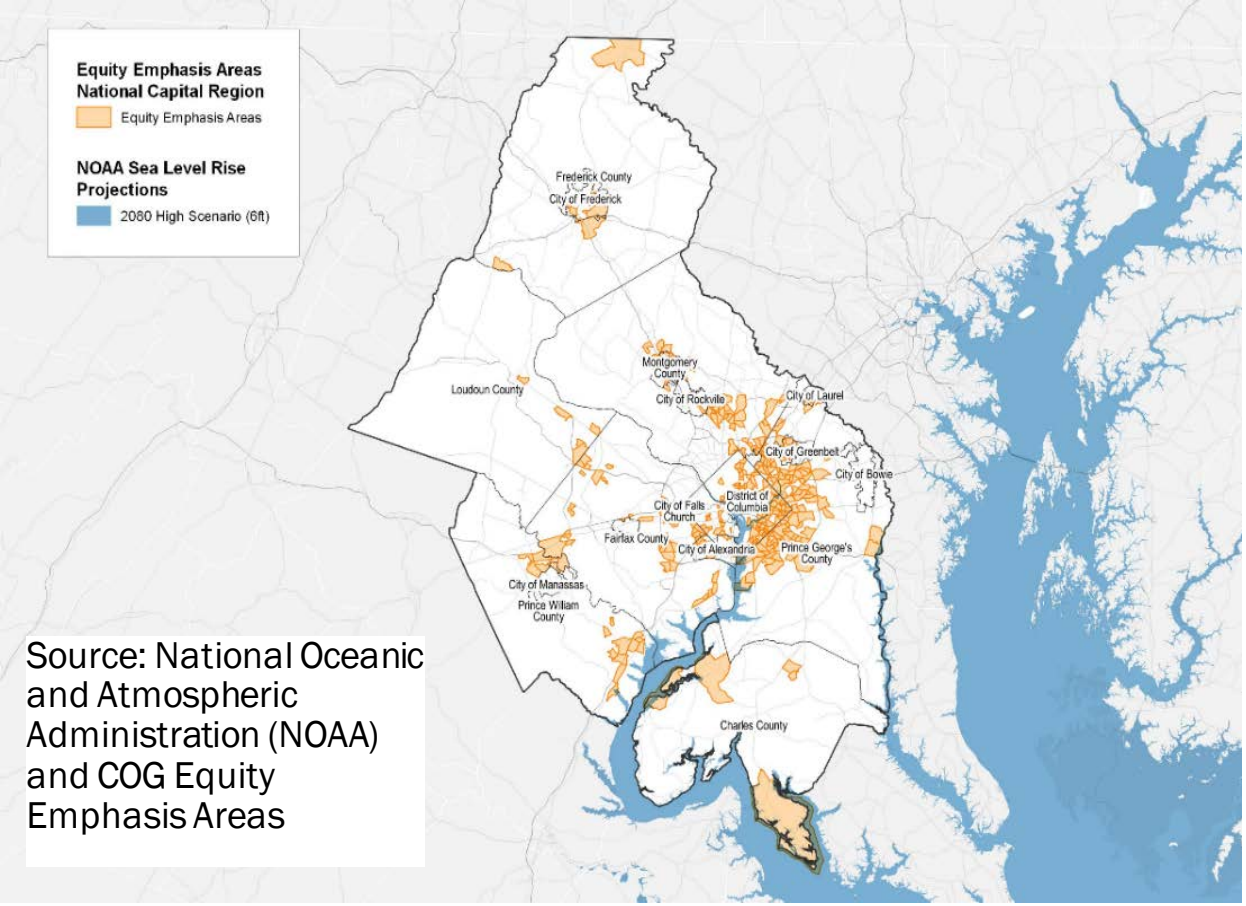
Source: NOAA Climate Explorer

Equity Emphasis Areas and 100-Year Floodplains



Source: Federal Emergency Management Agency (FEMA) and COG Equity Emphasis Areas

Equity Emphasis Areas and Sea Level Rise



Source: National Oceanic and Atmospheric Administration (NOAA) and COG Equity Emphasis Areas

Resilience Actions

Climate Action Area	Action ID	Priority Collaborative Action
Planning	PL - 2	Support Capacity Building for Climate Resilience Planning
	PL - 3	Develop Integrated Approach to Climate Resilience Planning
	PL - 4	Update Local Regional Plans to Address Climate Risks
Equity	EQ - 3	Support Engagement of the Public on Climate Risks, with a Particular Emphasis on Potentially Vulnerable Populations
	EQ - 4	Support Equitable Secure Energy Access
Resilient Infrastructure	RI - 1	Support Establishment of Resilience Hubs
	RI - 2	Improve the Resilience of Critical Infrastructure
	RI - 3	Implement Measures to Equitably Address Urban Heat Island
	RI - 4	Enhance Green Infrastructure Networks
	RI - 5	Implement Measures to Reduce Flood Risk

Timeline

Month	Priority Next Steps
September 2020	Presentation to COG Board
	Draft Plan & Climate Goals Resolution Review by ACPAC, BEEAC, CEEPC
	CEEPC Recommends Goals to the COG Board
October 2020	2030 Climate Goal Resolution before COG Board
	Draft Plan Comment Period ends October 16. Submit comments to climate2030@mwcog.org.
	Additional Draft Plan Q&A Virtual Session(s)?
November 2020	Updated DRAFT Plan before CEEPC for adoption
December 2020	Submit to GCoM
	1st US Region fully meeting GCoM global standards for climate planning

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METROPOLITAN WASHINGTON 2030 CLIMATE AND ENERGY ACTION PLAN - DRAFT

A collaborative implementation plan of the Climate, Energy and Environment Policy Committee (CEEPC) to move toward a carbon neutral and resilient region.

Commented [MD1]: This statement assumes the COG Board will adopt new goals in October 2020.

September 2020

Metropolitan Washington
Council of Governments

METROPOLITAN WASHINGTON CLIMATE ACTION PLAN
Prepared by the Climate, Energy and Environment Policy Committee (CEEPC)
Adopted on [November 18, 2020]

Commented [MD2]: Future data placeholder - This is th date of the CEEPC meeting when members will be asked to adopt the plan.

ABOUT COG
The Metropolitan Washington Council of Governments (COG) is an independent, nonprofit association that brings area leaders together to address major regional issues in the District of Columbia, suburban Maryland, and Northern Virginia. COG's membership is comprised of 300 elected officials from 24 local governments, the Maryland and Virginia state legislatures, and U.S. Congress.

CREDITS
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[External support described here. To be inserted]

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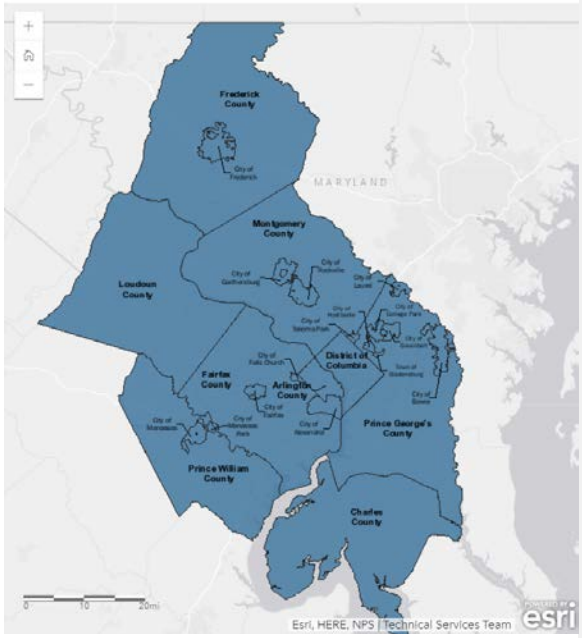
FIGURES AND TABLES

INTRODUCTION

COG and the Region

Metropolitan Washington is a diverse and dynamic region home to more than five million people and one of the nation's largest economies. The Metropolitan Washington Council of Governments (COG) is an independent, nonprofit association comprised of 24 jurisdictions featuring urban, suburban, and rural communities across metropolitan Washington that range in size from about 10,000 to more than one million residents (Figure 1).

Figure 1: COG Region and Member Local Jurisdictions



COG is a center for partnerships to facilitate sustainable growth, a well-maintained transportation system, clean air, water, and land, safe and healthy communities, and a vibrant economy. This work is guided by COG's comprehensive *Region Forward Vision*, a commitment to bettering the region, shared by residents, business and nonprofit leaders, and elected officials across metropolitan Washington. These goals also encourage leaders to think about the regional impact of local decisions. The *Region Forward* goals are:[i]

Climate and Energy

- We seek a significant decrease in greenhouse gas (GHG) emissions, with substantial reductions from the built environment and transportation sector.
- We seek efficient public and private use of energy region-wide, with reliance upon renewable energy and alternative fuels for buildings, vehicles, and public transportation.

Environment

- We seek to maximize protection and enhancement of the region's environmental resources by meeting and exceeding standards for our air, water, and land.
- We seek preservation and enhancement of our region's open space, green space, and wildlife preserves.

Transportation

- We seek a broad range of public and private transportation choices for our region which maximizes accessibility and affordability to everyone and minimizes reliance upon single occupancy use of the automobile.
- We seek a transportation system that maximizes community connectivity and walkability and minimizes ecological harm to the region and world beyond.

Land Use

- We seek the enhancement of established neighborhoods of differing densities with compact, walkable infill development, rehabilitation and retention of historic sites and districts, and preservation of open space, farmland, and environmental resource land in rural areas.
- We seek transit-oriented and mixed-use communities emerging in Activity Centers that will capture new employment and household growth.

Housing

- We seek a variety of housing types and choices in diverse, vibrant, safe, healthy, and sustainable neighborhoods, affordable to persons at all income levels.
- We seek to make the production, preservation, and distribution of affordable housing a priority throughout the region.

Economy

- We seek a diversified, stable, and competitive economy, with a wide range of employment opportunities and a focus on sustainable economic development.
- We seek to minimize economic disparities and enhance the prosperity of each jurisdiction and the region as a whole through balanced growth and access to high-quality jobs for everyone.
- We seek to fully recognize and enhance the benefits that accrue to the region as the seat of the national government and as a world capital.

Health and Human Services

- We seek communities in which every person enjoys health and well-being.

Education

- We seek to provide greater access to the best education at all levels, from pre-kindergarten to graduate school.
- We seek to make our region a pre-eminent knowledge hub, through educational venues, workforce development, and institutional collaboration.

Public Safety

- We seek safe communities for residents and visitors.
- We seek partnerships that manage emergencies, protect the public health, safety, welfare, and preserve the lives, property, and economic well-being of the region and its residents.

Equity

- We recognize equity is achieved when all people are fully able to participate in the region's economic viability, contribute to the region's readiness for the future and connect to the region's assets and resources.
- We seek fairness and justice in the formation of priorities, policy, and programs.
- We will be anti-racist, actively oppose racism, and will advance equity in our work together across the region.

The Board of Directors is COG's governing body and is responsible for its overall policies. A wide network of policy, technical, and advisory committees, partnerships, and programs advance COG's work to achieve the *Region Forward Vision*.

COG's Climate and Energy Program

BACKGROUND [ii]

In 2007, the Metropolitan Washington Council of Governments (COG) celebrated its 50th anniversary. As part of its 50th anniversary year, the COG Board of Directors examined the extraordinary changes that took place during the first half century of COG's existence and how COG grew up along with the region and helped shape its growing and vibrant communities. The Board then set its sights on the next fifty years. It recognized global climate change as a profound force fundamental to defining the decades ahead. The Board resolved that the region would become a leader in the growing national and international effort to combat this major challenge to the region's quality of life.

On April 11, 2007, the Board adopted Resolution R31-07, creating a regional climate change initiative. In its resolution, the Board stated: "The failure to reduce greenhouse gases can undermine the quality of life in our region and its economic and environmental sustainability." The Board action called for creating a one of the nation's first regional climate change programs that would include developing a greenhouse gas inventory, setting regional goals, identifying best practices for reducing emissions, advocating policies at the federal and state levels, making recommendations on regional climate change policy, and recommending a structure to guide COG's efforts in the future.

By adopting R31-07, the COG Board established one of the first regional climate and energy programs in the United States and placed itself front and center on the national landscape of local jurisdictions and states taking leadership action on climate change. Resolution R31-07 established a Climate Change Steering Committee (CCSC) to guide the initiative. The committee's work ultimately led to the development of the National Capital Region Climate Change Report.

The National Capital Region Climate Change Report includes a 2005 baseline regional GHG inventory, examines potential climate change impacts, evaluates mitigation and adaptation strategies and establishes regional GHG emission reduction goals of: 10 percent below business as usual projections by 2012 (bringing regional emission back down to 2005 levels), 20 percent by 2020 and 80 percent by 2050 (below the 2005 baseline). The COG Board of Directors adopted this report and its goals with Resolution R60-08 on November 12, 2008. The Board also established the Climate, Energy and Environment Policy Committee (CEEPC) to move the region toward meeting the regional GHG emission reduction goals.

CLIMATE, ENERGY AND ENVIRONMENT POLICY COMMITTEE

The CEEPC guides the COG region in taking action to meet regional GHG emission reduction goals. CEEPC supports the *Region Forward Vision* by providing leadership and advising the COG Board on climate change, energy, green building, alternative fuels, solid waste and recycling issues, and by supporting area governments as they work together to meet regional goals.[iii]

CEEPC includes representatives from COG's member local governments, state environmental and transportation agencies, state legislatures, the Air and Climate Public Advisory Committee (ACPAC), federal and regional agencies, electric and gas utilities, environmental organizations, business organizations, and members of the academic community. Several subcommittees, technical working groups, and partners provide essential input and support to CEEPC, including:[iv]

Commented [MD3]: If the COG Board adopts the proposed goals for mitigation and resilience at the October 2020 COG Board meeting, should we add info here or are the descriptions elsewhere sufficient?

- The **Climate and Energy Legislative Committee** leads the development of the COG Board's annual legislative priorities for climate and energy and advocates at the state and federal levels for policies and programs that support regional GHG emission reduction and enhances climate resilience. This committee consists of a sub-group of the local elected officials appointed to CEEPC.

- The **Air and Climate Public Advisory Committee** (ACPAC) provides a meaningful opportunity for appointed members of the public to advise CEEPC on climate and energy issues and initiatives. ACPAC's members represent diverse community interests and opinions from across the region. Members have various backgrounds including business/industry, education/scientific, environmental/health and civic organizations.

- The **Built Environment and Energy Advisory Committee** (BEEAC) serves as a technical advisory committee to CEEPC. Membership includes local government energy managers, green building program managers, sustainability coordinators and regional stakeholders, such as Metro. The group serves as a forum for discussion, sharing/learning, and monitoring of energy and green building issues in the region.

- The **Regional Emergency Support Function #12** (RESF-12) is an energy committee coordinated by BEEAC members in cooperation with COG's Homeland Security and Public Safety Program. The group is responsible for coordinating with state and local agencies and emergency response teams to maintain continuous and reliable energy supplies through preventive measures, restoration, and recovery actions.

- The **Regional Tree Canopy Committee** (RTCC) is dedicated to maintaining a healthy tree and forest canopy in the face of climate change and an ever-changing landscape of air quality and stormwater management regulations. Committee members include local foresters and climate, air quality and stormwater experts who work together to facilitate a unified approach to tree and forest canopy management efforts.

- The **Solid Waste Managers and Recycling Committees** are comprised of COG member local jurisdiction representatives working on solid waste and recycling. Members come together to share best practices and lessons learned as well as tackle regional challenges such as commercial recycling, recycling markets, and advancing organics composting infrastructure in the region.

- The **Greater Washington Region Clean Cities Coalition** (GWRCCC) works with vehicle fleets, fuel providers, community leaders and stakeholders to reduce petroleum use in transportation. Initially launched and housed as a COG program, the GWRCC grew to a separate private-public partnership that still closely collaborates with COG to advance deployment of zero emission vehicles.[v]

- A plethora of **Ad-Hoc Work Groups** have been established to operate for limited timeframes or come and go as needed to advance significant new initiatives or address members' needs. Examples of work group focuses have been establishing greenhouse gas accounting methodologies; developing model energy engagement programs; developing an electric vehicle readiness plan for the region; developing model solar permitting and inspections checklists and review processes; training for and developing model commercial PACE (Property Assessed Clean Energy) programs, policies and procedures; and much more.

PROGRESS

Since its inception, CEEPC has adopted short-term plans to set priorities and spur action. Each plan builds off the last, to help move the region toward its goals to reduce GHG emissions, enhance resilience, and address the newest practices and member needs. CEEPC consistently pushes the bar for the outcomes they want to see for the region and then members work to help accomplish those outcomes. There has been a tremendous amount of effort in the region on climate and energy action the last 10-15 years and while it would be difficult to capture it all in this plan, some highlights of commitments, accomplishments and initiatives are provided. Some examples of overall progress include:[vi]

- The region surpassed its 2012 goal of 10 percent reduction in greenhouse gas (GHG) emissions below business as usual projections, bringing regional emission back down to 2005 levels. Overall emissions region-wide have decreased 13 percent between 2005 and 2018, despite a 19 percent growth in population. An immense undertaking is still needed to meet the GHG reduction goals moving forward.

- As of 2018, 13 percent of total regional electricity consumption came from renewables. This equates to more than 8.9 million MWHs of renewables.

- The region has surpassed both CEEPC's 2016 goal of 5,000 grid-connected renewable energy systems in the region and its 2020 goal of 30,000 systems. Distributed renewable energy deployment has grown at a tremendous rate from less than 470 systems in 2009 to more than 44,000 systems in 2019 operating with more than 479 megawatts of capacity.

- Buildings with a higher level of environmental performance are verified through programs such as LEED, ENERGY STAR, EarthCraft, Passive House and Living Buildings Challenge. The number of these certified high-performance buildings have grown from 3 buildings in 2005 to 4,198 buildings in the region as of summer 2019.
    - Metropolitan Washington is consistently ranked in the top few metropolitan areas for ENERGY STAR rated buildings. In 2020, the Washington D.C. metro area was ranked 2nd for ENERGY STAR certified buildings.[vii]
    - Maryland and Virginia are consistently ranked in the top 10 states for LEED development. In 2019, Maryland was ranked 6th and Virginia was ranked 7th for gross square footage of new space LEED certified. Although the District of Columbia is not officially included in the state rankings, the rankings recognize that the District had more LEED development than any state in the 2019 rankings.[viii]

- Hybrid and electric vehicles owned in the region have grown from 11,843 hybrids in 2005 to 123,826 hybrid and electric vehicles in 2016. Only 8,225 of these vehicles are plug-in (PHEV) or all electric (BEV) that need to plug into charging stations. As of 2016, hybrid and electric vehicles together account for 3 percent of all light duty vehicles in the region.

- Owners of plug-in and all electric vehicles need to be supported with a robust network of charging stations. Charging stations locations in the region increased from 124 in 2012 to 852 in 2019. The 852 station locations include 2,424 charging plugs.

- The regional recycling rate, one indicator to track progress towards zero waste, has increased from approximately 33 percent in 2005 to 47 percent in 2016.

Commented [MD4]: This section and its associated appendices do not include an exhaustive list of local, regional and state climate action initiatives. We could however consider including more examples of local, regional and state resilience initiatives.

Regional Initiatives

COG's Climate and Energy Program provides support and resources to communities seeking to implement policies, programs and initiates to reduce GHG emissions and enhance resilience. Types of support may include capacity building and training, data and tools, research, planning, policy/program development, project feasibility assessments, advocacy, and cooperative procurement. Areas of focus for the COG Climate and Energy Program have been greenhouse gas accounting, efficiency and green building, renewables, energy financing, energy infrastructure, clean fuel vehicles, emergency preparedness, urban tree canopy, recycling and waste management, climate resilience planning, cooperative procurement, equity, and engagement. COG local jurisdictions, states, and stakeholders work together to learn from experts and each other and to help facilitate implementation at-scale. Some examples of our collaborative work include:

- **Greenhouse Gas Accounting**: Since its inception, CEEPC has made it a priority for all COG member jurisdictions to conduct GHG inventories to track progress towards emission reduction goals. COG's GHG inventory work provides for completeness, consistency, accuracy, replicability, transparency, and quality control for all 24 COG members and the region. In addition, COG continues to support enhancements to national protocols for community-scale inventories and development of tools to support decision-making.[ix]

- **Green Building:** COG's Intergovernmental Green Building Group (IGBG) was established in 2005 and lead development of the Regional Green Building Policy that the COG Board adopted in 2007. It called for all new local government construction to achieve Leadership in Energy and Environmental Design (LEED) Silver Certification and all commercial construction to be LEED Certified. The policy and IGBG encouraged and supported wide-spread adoption of local green building policies that have significantly influenced green building development in the region. IGBG eventually merged with COG's Energy Advisory Committee to form BEEAC where continued capacity building, training and encouragement of enhanced green building policies continues.[x]

- **Renewables**: Coordinated bulk procurement initiatives helped result in more than 31 megawatts of solar deployment as of 2016. In 2010, the EPA GPP, COG and its members partnered to conduct 170 on-site solar feasibility assessments at public facilities and coordinated on bulk solar procurements. Under the U.S. Department of Energy SunShot Initiative, COG and its members partnered to adopt model solar permitting and inspection guidelines and launch solar co-ops in a dozen communities, many of which have continued to launch additional co-ops rounds.[xi]

- **Energy Financing**: The Mid-Atlantic PACE Alliance (MAPA) is a partnership between stakeholders in Virginia, Maryland, and the District of Columbia - including COG - to accelerate the implementation of Commercial Property Assessed Clean Energy (C-PACE) programs and projects in the region. C-PACE is a financing mechanism for owners of commercial property to fund energy-related property improvements with no upfront costs. The MAPA Toolkit offers comprehensive program development guidelines for local governments. More than 10 PACE Programs have been launched and 35 projects in the region have been financed as of summer 2020 by C-PACE programs.[xii]

- **Energy Infrastructure**: The accomplishments of CEEPC and its members have also earned the region recognition as a White House Climate Action Champion. This designation made COG and its members eligible for targeted federal technical assistance and grant funding from 2014 – 2016. One way COG leveraged this opportunity was to conduct local clean

energy infrastructure assessments at 6 sites across the region to determine the feasibility of microgrids, combined heat and power (CHP), geothermal or net zero energy development. Two examples of progress at these sites include the Falls Church School Campus is developing a net zero energy ready school campus with geothermal and the Washington Hospital Center is seeking funding for microgrid deployment.

- **Clean Fuel Vehicles**: In 2015, COG partnered with Vision Fleet to develop opportunity assessments to maximize overall fleet efficiency for four local government vehicle fleets, including the District of Columbia, Alexandria, Prince George's County and Frederick County. Complete light-duty fleet inventories included detailed, vehicle-specific total cost of ownership estimates and more efficient, cost-effective substitutes for each vehicle. The comprehensive assessment recommendations were both quantitative and qualitative to maximize financial and fuel savings and reduce carbon emissions through electric vehicle deployment, car-sharing programs, strategic right-sizing, or increase asset utilization.[xiii]

- **Emergency Preparedness**: COG has been doing energy emergency coordination since the 1970s gas shortage crisis and the development of the 1973 Metropolitan Washington Tri-State Energy Emergency Coordination Agreement. Regional plans and coordination over the years have addressed energy conservation and management, natural gas emergency alerts, and energy emergencies. The most recent plan addressing energy emergencies is the 2010 Regional Emergency Coordination Plan. Over the years, COG has coordinated several energy emergency exercises with emergency responders, local energy managers, and energy and water utilities.

- **Urban Tree Canopy**: CEEPC formed a Tree Canopy Subcommittee to further recommendations of the 2018 Tree Canopy Management Strategy. The Subcommittee is developing a "cook book" of model tree ordinance provisions, recommendations for minimum percent tree canopy coverage for differing land use types, and a Regional Tree Canopy Acton Plan.

- **Recycling and Waste Management**: COG works with local waste management and recycling program managers, waste management and recycling companies, and other stakeholders to share best practices, market conditions, and other information to assist optimization of local waste management and recycling practices. COG sponsors the annual Go Recycle public information program and the America Recycles Day program with schools across the region.

- **Climate Resilience Planning**: COG is currently coordinating with the U.S. Army Corps of Engineers Baltimore District and local cost-share partners on a coastal storm risk management study to evaluate the performance of current flood protection infrastructure along the northern Virginia bank of the Potomac and its tidal tributaries. The project includes analyzing tidal flooding risks and developing designs for new flood protection systems–including green and gray infrastructure–to reduce to risk to northern Virginia communities and built assets.[xiv]

- **Cooperative Procurement:** The basic objective of COG's Cooperative Procurement Program and our Mid-Atlantic Purchasing Team (MAPT) is to reduce costs through economies of scale created through volume buying. The COG Rider Clause provides the opportunity for members to join existing awards and avoid the need to do in-house bidding. CEEPC and its members have leveraged the program and rider clause for procurements such as solar, energy efficient lighting, electric vehicles, and climate planning.[xv]

- **Equity**: Adopted by CEEPC in 2017, the Environmental Justice Toolkit provides guidance to policymakers on incorporating social equity, cultural sensitivity, and community health considerations into air quality, climate, and energy planning. Environmental justice has been a priority of ACPAC and members took the lead on developing the toolkit to help communities address issues of equity, access to decision makers, and meaningful engagement of the public, when making decisions that affect the local and regional environment.[xvi]

- **Engagement**: COG's Climate and Energy Leadership Awards, coordinated by ACPAC, recognizes organizations that develop climate stewardship projects and programs that engage and serve the region's underserved communities. Over the last 6 years, the awards program has highlighted a broad range of climate solutions for their unique engagement practices as well as their results, creativity, and replicability.[xvii]

Local Goals and Commitments

COG's *Region Forward* Vision focuses on creating a more prosperous, accessible, livable, sustainable, and equitable metropolitan Washington. All COG local jurisdiction members in 2010 signed onto the *Region Forward* goals by adopting via their local governing body (i.e. city council, county commission). The climate and energy goals include commitments to reducing GHG emissions and the efficient use of energy, with reliance on renewable energy and alternative fuels.

The majority of COG members have adopted specific local GHG emission reduction goals that align with the COG goals adopted by the Board in 2008. The Cities of Alexandria, Frederick and Takoma Park as well as Frederick and Montgomery Counties have declared climate emergencies that commit to achieving more aggressive GHG goals sooner. For example, Montgomery County's Emergency Climate Mobilization Resolution established goals for the County to reduce GHG emissions to 80 percent below 2005 levels by 2027 and to 100 percent by 2035. The other jurisdictions who have declared emergencies, as well as the District of Columbia and Arlington County, also have committed to carbon neutrality by 2035 or 2050.

Additionally, more than half of COG members committed to the We're Still In Pledge, a commitment to support climate action to meet the Paris Agreement. Several COG members have also made commitments to reduce GHG emissions to initiatives such as the Global Covenant of Mayors for Climate and Energy, Climate Mayors, and much more.

For a complete list of local GHG reduction goals, climate action plans, and commitments, see Appendix C: List of Metropolitan Washington GHG Emission Reduction Plans and Goals and Appendix D: COG Member Collaborative Climate Program Commitments. Sample highlights of local actions to support reaching their goals are weaved into the Mitigation and Resilience Strategy sections of this plan.

State Goals and Commitments

Table 1 shows the State Goals and Commitments that are currently in place. Renewable Portfolio Standards (RPS) are the most impactful tool to reduce the amount of fossil fuel-generated electricity on the grid. The District of Columbia, Maryland, and Virginia have all adopted aggressive RPS goals. The District of Columbia, Maryland and Virginia have adopted buildings codes that drive greater energy efficiency in the built environment. Additionally, the District of Columbia and Maryland are part of the Regional Greenhouse Gas Initiative (RGGI), which establishes a regional cap on the amount of carbon dioxide (CO_2) emissions that can be emitted by power plants. This is achieved through the issuance of tradable CO_2 allowances. Virginia is set to join RGGI on January 1, 2021. The

District of Columbia, Maryland, and Virginia are all participating in the Transportation Climate Initiative (TCI). This initiative is a collaboration of 12 states and the District, which seeks to reduce carbon emissions from the transportation sector.

Table 1: State Goals, Commitments and Legislation that Support GHG Reduction

Goals/Commitments	District of Columbia	Maryland	Virginia
Greenhouse Gas Reduction Goals*	50% Reduction below 2006 levels by 2032	40% Reduction below 2006 levels by 2030	N/A
	Carbon Neutral by 2050	N/A	N/A
Renewable Portfolio Standards	100% by 2032	50% by 2030, and 100% by 2040	30% by 2030, and 100% by 2050
Adopted Building Codes:**			
International Energy Conservation Code (IECC)	2015 IECC	2018 IECC	2015 IECC
International Green Construction Code (IgCC)	2012 IgCC	2018 IgCC	N/A
Regional Greenhouse Gas Initiative (RGGI) Participation	✔	✔	Pending - Virginia is scheduled to join RGGI in January 2021
Transportation Climate Initiative (TCI) Participation	✔	✔	✔

*Greenhouse Gas Reduction Goals reflected in Table 1 are state-level goals and do not reflect COG's regional GHG reduction goals or more aggressive goals made by local jurisdictions in the metropolitan Washington region.

**All Building Codes reflected in Table 1 have amendments made at the state level.

For a complete list of state GHG reduction goals, commitments and legislation that support GHG reduction, see Appendix D: COG Member Collaborative Climate Program Commitments and Appendix E: List of State Legislation Supporting GHG Emission Reduction in Metropolitan Washington.

THE PLAN

Purpose and Scope

According to the Intergovernmental Panel on Climate Change (IPCC), a body of the United Nations that assesses the science related to climate change, the world is already experiencing the impacts of 1 degree of global warming above pre-industrial levels. Additionally, the IPCC notes that more severe climate impacts could be avoided if global warming is limited to 1.5 degrees Celsius. Globally emissions need to fall by 45 percent from 2010 levels by 2030 and net zero by 2050 in order to limit global warming to 1.5 degrees Celsius. The IPCC acknowledges rapid and far reaching transitions are needed world-wide in order to limit global warming.[xviii]

The greenhouse gas (GHG) emission reduction goals adopted by the COG Board on October 14, 2020 align with the level of effort called for by the IPCC to limit global warming to 1.5 degrees Celsius. The goals established by the COG Board include the following:

Commented [MD5]: This description of goals assumes the COG Board will adopt new goals at its October meeting.

- Mitigation:
  - Reduce Regional GHG emissions 50 percent by 2030, below 2005 levels; and
  - Achieve carbon neutrality region-wide by 2050.

- Resilience:
  - Become a Climate-Ready Region by 2030; and
  - Achieve Regional Resilience by 2050.[1]

The purpose of this plan is to establish priority collaborative actions for CEEPC members to work on together over the next ten years to help move the region towards meeting the 2030 goals. All the actions in the plan are voluntary; the success of the plan will depend on active regional collaboration and implementation. This plan focuses on the actions of the CEEPC; however, the plan also recognizes transportation and land use actions being undertaken by other COG committees that contribute to these climate goals. Achieving the regional goals would require unprecedented, aggressive cross-sectoral action from all 24 COG member local jurisdictions, as well as our state and federal partners.

GUIDING PRINCIPLES

Ten principles guide this Plan's voluntary collaborative climate action implementation process. These principles reflect CEEPC's commitment to environmental quality, economic prosperity, and equity. As climate leaders, CEEPC is committed to the following principles:

1. **Collective Action**: We will continue to work together to leverage our impact and facilitate application at scale.
2. **Effective Partnerships**: We will continue to share best practices, learn together, and coordinate on implementation to advance regional transformation.
3. **Lead by Example**: We have a continued commitment to internal implementation of long-term solutions to reduce the climate impacts of our operations.
4. **Integration:** We understand climate action is inherently multidisciplinary and will promote cross-department coordination, including in areas such as equity, health, and economic development.

[1] Resilience goals are further described in the Climate Resilience Strategy Section

5. **Flexibility**: We understand the need for flexibility in how our public agencies and stakeholders across the District of Columbia, Maryland, and Virginia work to achieve regional GHG goals.
6. **Transparency**: We will continue to measure and report progress in a manner easily understandable by all.
7. **Innovation**: We support a just transition to a clean energy economy through the application of innovative technology, policies, and processes by public and private sectors.
8. **Community Leadership**: We will continue to educate, motivate, and empower action from our community's institutions, businesses, non-profits, and residents.
9. **Inclusive Engagement**: We commit to inclusive community engagement and equitable provision of climate and energy programs and services.
10. **Advocacy**: We will continue to support state and federal policies and programs that protect the human and environment health of our communities.

GLOBAL COVENANT OF MAYORS FOR CLIMATE AND ENERGY

In 2019, COG was selected as a Regional and Metro Scale Climate Leader by the Global Covenant of Mayors for Climate and Energy (GCoM). GCoM provides a framework of global best practices for climate planning. CEEPC became a GCoM Signatory, committing to follow the framework for the development of this Plan. GCoM has provided COG with guidance and technical assistance to ensure this Plan follows the GCoM framework.[xix]

The GCoM framework requires inventories, targets, and plans of Signatories to follow their global best practices. The framework breaks the planning process into two areas. The first addresses baseline conditions and mitigation actions to reach regional GHG emission reduction goals. The second involves completion of a regional Climate Risk and Vulnerability Assessment (CRVA) and identification of resiliency actions to reduce the risk and make the region more climate change ready.

In addition, this Plan incorporates GCoM's priority for providing improved access to secure, sustainable, and affordable energy. While the protocol has not been fully defined for North American energy markets, it accommodates addressing equitable access to clean and secure renewable power sources at affordable prices and providing energy-efficient housing to all sectors of the market.

Plan Elements

There are four core elements to this Plan, including:

- **Greenhouse Gases**: This section of the plan provides a summary of regional GHG inventory trends from 2005 – 2018, business-as-usual (BAU) GHG emission projections through 2030, and technical scenario showing what it will take for the region to reach GHG reductions of 50 percent below 2005 levels by 2030.

- **Climate Mitigation Strategy**: This section of the plan identifies CEEPC's priority collaborative mitigation actions to move the region toward achieving the GHG emission reduction goal of 50 percent by 2030, below 2005 levels. The action areas include Planning, Equity, Clean Electricity, Zero Energy Buildings, Zero Emission Vehicles, Zero Waste, and Sequestration.

- **Climate Risks and Vulnerabilities**: This section of the plan provides a summary of the Regional Climate, Risk and Vulnerability Assessment (CRVA). The CRVA evaluates climate hazards including extreme heat, drought, lightning and thunderstorms, flash and riverine flooding, coastal flooding and extreme winter conditions. The CRVA also evaluates factors impacting adaptive capacity, such as infrastructure conditions and maintenance, access to basic services, and public health.

- **Climate Resilience Strategy**: This section of the plan identifies CEEPC's priority collaborative climate resilience actions to move the region toward achieving the goal of becoming a Climate-Ready Region 2030. The action areas include Planning, Equity, and Resilient Infrastructure.

Stakeholder Engagement

The core stakeholder groups engaged during the development of the Metropolitan Washington 2030 Climate and Energy Action Plan were COG's Air and Climate Public Advisory Committee (ACPAC), the Built Environment and Energy Advisory Committee (BEEAC), and the Climate, Energy and Environment Policy Committee (CEEPC). These bodies and its members work together to implement the Plan's recommendations both locally and regionally. ACPAC serves as the public advisory committee to CEEPC and BEEAC serves as the technical advisory committee to CEEPC. CEEPC is the COG policy committee on climate and energy and the lead advisor on these issues to the COG Board. The COG Board establishes the overarching climate goals for ACPAC, BEEAC and CEEPC to work towards and is the final authority adopting regional goals. More information about these bodies can be found in the Introduction section of this Plan.

At its September 25, 2019 meeting, CEEPC became a GCoM Signatory and officially launched the development of the 2030 Plan. As one of the first regions in the U.S. to commit to follow GCoM's framework, CEEPC pledged to implement policies and undertake measures to reduce GHG emissions, prepare for the impacts of climate change, increase access to sustainable energy, and track progress toward these objectives. CEEPC also reviewed the scope and timeline for the 2030 Regional Climate and Energy Action Plan that was developed to align with the GCoM framework. In advance of the September CEEPC meeting, CEEPC advisory committees, ACPAC and BEEAC, had the provided input and offer support for the GCoM commitment and scope for the Plan.[xx]

In November 2019, ACPAC, BEEAC and CEEPC members held a joint 2-day Climate Planning Work Session. The first day was dedicated to mitigation where the group reviewed progress towards regional 2020 goals and new drafts of the region's GHG emissions business-as-usual (BAU) projections and 2030 low carbon scenarios. The second day was dedicated to resilience where the group discussed the draft regional climate risk and vulnerability assessment (CRVA). Over the 2-day session, participants provided input on the challenges, opportunities and next steps related to regional goals, collaborative actions, sustainable energy access and equity for both mitigation and resilience.[xxi]

Based on input from the November Work Session, revisions were made to the BAU projections, scenarios and CRVA and goals and a preliminary list of priority collaborative actions were developed. Due to the outbreak of the COVID-19 pandemic, stakeholder engagement was pushed back by a month and stakeholder engagement for the remainder of the planning process moved to virtual platforms in leu of in-person engagement. Virtual stakeholder engagement sessions to move the Plan toward adoption included:[xxii]

- In April 2020, ACPAC, BEEAC and CEEPC members were invited participate in a virtual work session to review preliminary list of goals and actions for the 2030 Plan.
- In May 2020, CEEPC hosted a roundtable discussion on local climate goals, actions and progress. The impacts and effects of COVID-19 on climate planning and implementation were discussed.
- In June 2020, a technical Q&A webinar was held to review and provide input on BAU and scenario revisions.
- In July 2020, members of ACPAC, BEEAC and CEEPC had the opportunity to provide input on the revised 2030 Plan goals at their respective virtual meetings.
- In September 2020, the COG Board received an update on the planning process and potential goals.
- In September 2020, ACPAC, BEEAC and CEEPC reviewed the draft plan and draft resolution to the COG Board on updated regional climate goals. CEEPC approved the resolution to the COG Board.
- In October 2020, the COG Board reviewed and adopted the recommended resolutions from CEEPC, thus, establishing the most aggressive regional climate goals in the U.S.
- In November 2020, CEEPC approved the final 2030 Plan.
- In December 2020, COG submitted to the Plan to GCoM and became the first region in the U.S. to fully complete and meet the GCoM requirements for global best practices in climate planning.

Commented [MD6]: This is the proposed next steps. This language may need to be adjusted based on the needs and the decisions of the stakeholders and decision making bodies.

After each work session for the Plan, stakeholders were provided a comment period to allow time for further review and written comments.

Implementation and Monitoring

CEEPC and its advisory committees will follow the Guiding Principles identified above to work together to support implementation of this plan. For the region to meet the regional climate change goals, aggressive local actions and on-the-ground change will need to occur across the entire region. Additionally, the goals cannot be met if the climate injustices faced by underserved, potentially vulnerable communities are not addressed head-on. All climate action and implementation need to occur with an equity lens. The purpose of stakeholders voluntarily coming together to collaborate on action across the region, is to leverage our impact and facilitate innovation and action at scale.

In order to monitor progress toward the Plan's goals, COG will report out on progress every two years. As a GCoM Signatory, CEEPC developed this Plan to follow global best practices in climate planning, which includes reporting progress to GCoM every two years on implementation and progress on both mitigation and resilience. While the reporting survey template changes year-to-year and data availability may vary, progress reported may include greenhouse gas emissions, examples of local and regional action, and examples of implementation progress on this Plan's priority collaborative actions. This biennial update on progress will provide an opportunity to discuss progress with CEEPC and its advisory committees, discuss needs and new issues, and adjust next steps, as needed.

GREENHOUSE GAS EMISSIONS

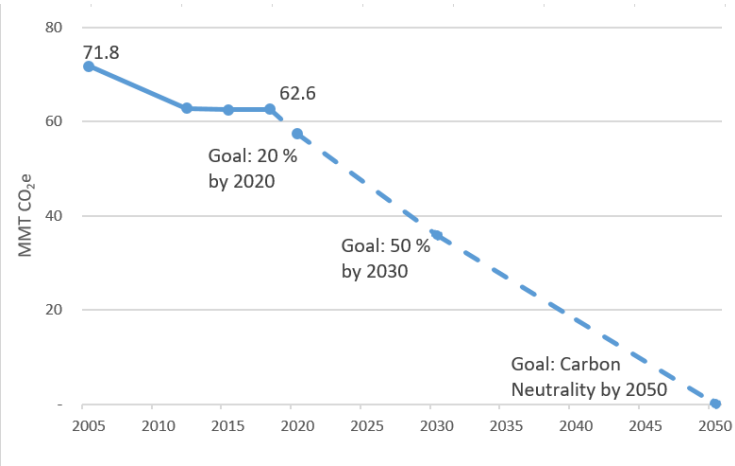
Inventory

Since its inception, the Climate, Energy and Environment Policy Committee (CEEPC) has made it a priority to track progress toward local and regional greenhouse gas (GHG) emission reduction goals. The ability to develop relevant, robust sets of inventories supports decision-making around policies and programs that reduce emissions. COG has completed GHG inventories for 2005, 2012, 2015, and 2018 to track progress towards the goals of 10 percent below the business as usual emissions projections by 2012 (back down to 2005 emission levels) and 20 percent below 2005 emissions by 2020.

COG's greenhouse gas inventories show that the region's progress to date towards the above goals has been mixed. The region exceeded its 2012 goal but is lagging on progress towards its 2020 goal. The most recent inventory indicates that 2018 GHG emissions in the region decreased by approximately 13 percent below 2005 levels. Despite a 19 percent growth in population, GHG emissions reduced from 71.8 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) in 2005 to 62.6 $MMTCO_2e$ in 2018. Per capita emissions decreased 27 percent between 2005 and 2018 from 15.6 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2005 to 11.4 $MTCO_2e$ in 2018. Expedited and concerted actions will be needed throughout the region to achieve future goals of 50 percent GHG emission reduction by 2030 and carbon neutrality by 2050 (Figure 2).

Commented [MD7]: This figure assumes the COG Board will adopt the proposed new goals in October 2020.

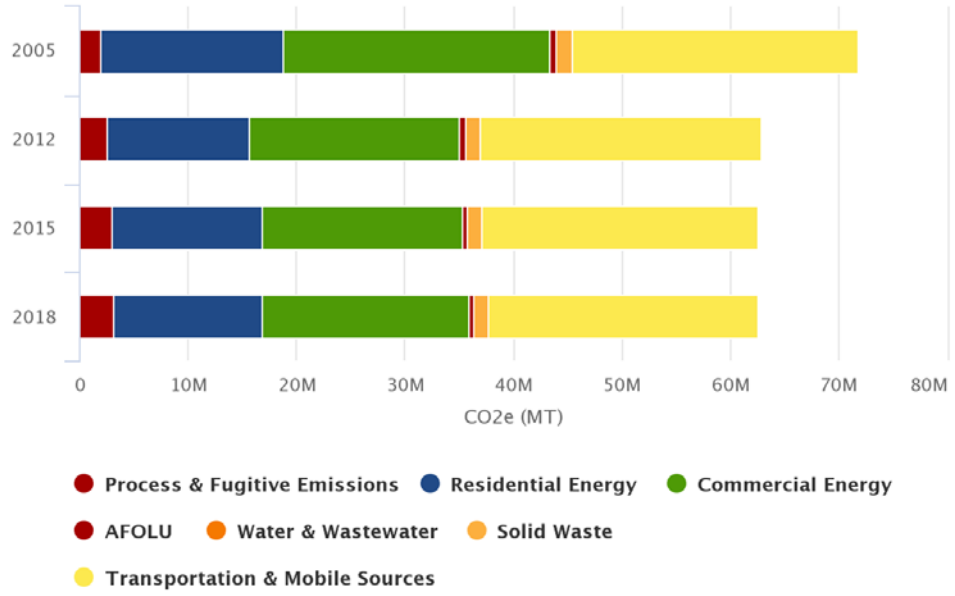
Figure 2: Metropolitan Washington GHG Trends and Goals



EMISSIONS ACTIVITIES

The inventories measure GHG-emitting activities undertaken by residents, businesses, industry, and government located in Metropolitan Washington, as well as emissions from visitors. More than 90 percent of metropolitan Washington's GHG emissions come from residential and commercial building energy consumption and transportation. Building energy consumption accounts for 50 percent and 42 percent is from transportation. The remainder of emissions comes from other activities and sources including solid waste, wastewater treatment, agriculture and fugitive emissions (Figure 3).

Figure 3: Metropolitan Washington GHG Emissions by Activity



Source: ICLEI's ClearPath, an online greenhouse gas inventory tool.

METHODOLOGY

The inventories have been developed to be compliant with both the U.S. Communities Protocol for Accounting and Reporting Greenhouse Gas Emissions (USCP), Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC), and Global Covenant of Mayors (GCoM) reporting framework. COG mainly follows the calculation guidance from USCP as the USCP identifies sources of data widely available to communities in the US. COG uses ICLEI's ClearPath tool Community Scale Inventory Module for preparing GHG inventories, which is consistent with both US and global accounting protocols.[xxiii]

COG makes every effort to capture a complete and accurate picture of GHG trends across the region, while also providing for a consistent methodology that is replicable across communities and inventory years. COG inventories follow an activities-based approach, meaning emissions are calculated based on the result of activities happening in each of the COG members' communities. Local results are totaled to create a picture for the region as a whole. For a detailed description of the methodology, see Appendix F: Greenhouse Gas Inventory Methodology.

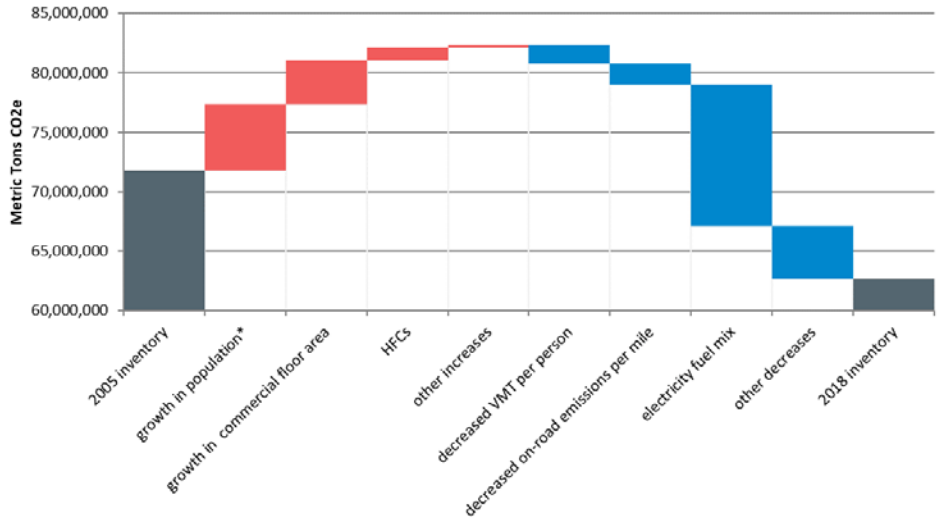
DRIVERS OF GHG CHANGE

ICLEI's GHG Contribution Analysis Tool evaluates the biggest drivers influencing GHG performance of cities, counties and regions. The tool provides for a deeper understanding of what is driving emissions changes between GHG inventory years to help identify and prioritize more effective actions to reduce GHG emissions. COG was a partner on a national team under the U.S. Department

of Energy Cities Leading through Energy Analysis and Planning (CLEAP) Program to develop the Contribution Analysis model and toolkit.[xxiv]

The metropolitan Washington GHG Contribution Analysis results in Figure 4 shows what has driven increases and decreases in emissions between inventory years 2005 and 2018. The main drivers increasing emissions (red bars) include growth in population, commercial space, and hydrofluorocarbons (HFCs). Driving down emissions (blue bars) is mainly a cleaner grid, cleaner cars and reduced vehicle miles traveled (VMT) per person.

Figure 4: Drivers of Metropolitan Washington GHG Changes



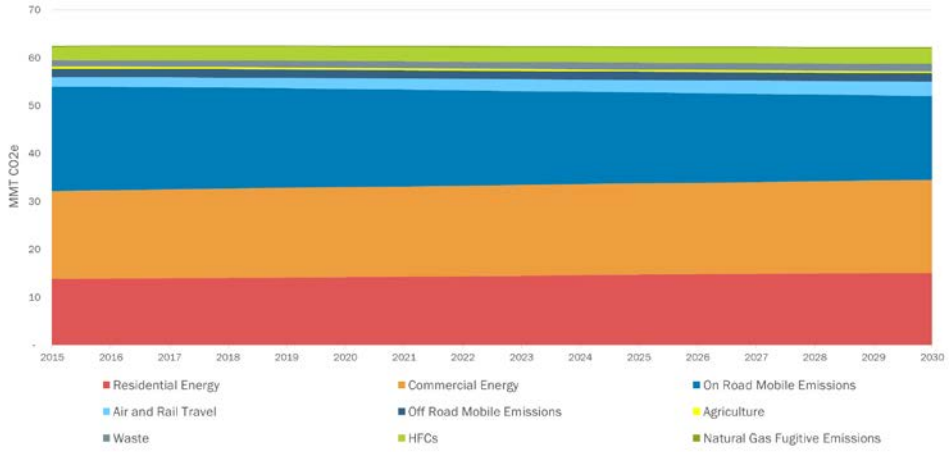
*Includes effects of population on residential energy, VMT and waste generation.

Business-As-Usual Projections[xxv]

Business-as-usual (BAU) projections provide a baseline scenario for future GHG emissions. BAU projections take into account driving factors such as growth in population, housing and commercial development and the impact they will have on future GHG emissions. BAU projections reflect policies and practices that have been in place and implemented to-date to reduce GHG emissions, but do not incorporate any additional GHG emission reductions from anticipated future action.

The metropolitan Washington BAU scenario for this Plan projected emissions out to 2030. Based on the assumptions used, total emissions overall remained flat between 2015-2030. Figure 5 shows the region's anticipated BAU emissions projected out to 2030. See Appendix G: BAU and 2030 Scenario Assumptions for a summary table on the assumptions.

Figure 5: Metropolitan Washington Business-As-Usual Projections

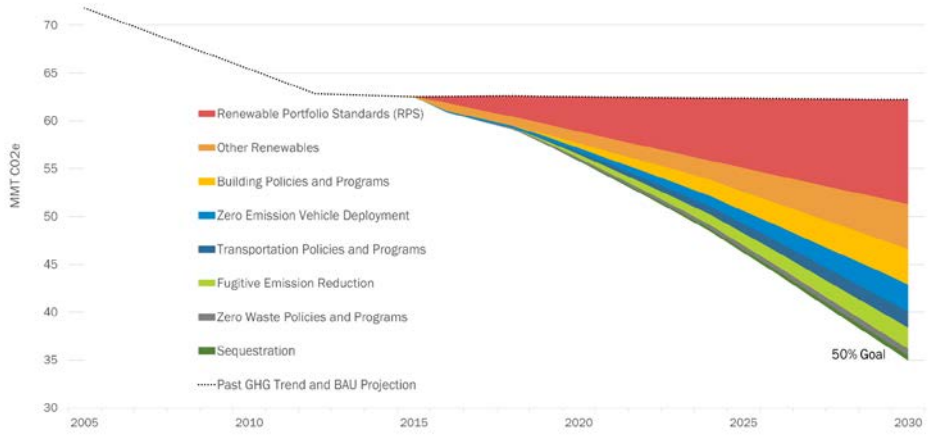


2030 Scenario

This scenario for this Plan analyzes the technical potential of "What Would It Take" for metropolitan Washington to reach a 50 percent reduction in GHG emissions from 2005 levels to 2030. This scenario leverages results from a previous scenario analysis conducted in 2015 by the Ad-Hoc Multi-Sector Work Group and results have been updated based on new data and progress since that time.

Figure 6 shows a summary of the results to the "What Would It Take" scenario to reduce emissions 50 percent by 2030. The implementation of state Renewable Portfolio Standards will have the most significant impact on reducing emissions. Considerable action across local, regional, state and national levels will be needed. See Appendix G: BAU and 2030 Scenario Assumptions for a summary table on the assumptions.[xxvi]

Figure 6: Metropolitan Washington "What Would It Take" Scenario Results



REGIONAL CLIMATE MITIGATION STRATEGY

Moving Toward Zero

The Regional Mitigation Strategy includes collaborative actions to support the region in achieving the greenhouse gas (GHG) emission reduction goals of 50 percent by 2030, below 2005 levels, and carbon neutrality by 2050. In order to move the region toward net zero emissions the region needs to emphasize an equitable transition to clean electricity, zero energy buildings, zero emission vehicles and zero waste as well as enhance the net benefits of sequestration.

PRIORITY COLLABORATIVE MITIGATION ACTIONS

The climate action areas included in the Regional Climate Mitigation Strategy address Planning, Equity, Clean Electricity, Zero Energy Buildings, Zero Emission Vehicles, Zero Waste, and Sequestration. Within these action areas are high-level priority actions for CEEPC and its members to focus on through 2030. All actions are voluntary. Actions have a 1-page description that includes:

- An action overview with example policies, programs, or projects;
- How the action supports regional GHG emission reduction goals;
- Identifies what level of implementation is needed by 2030 and beyond (based on the "What Would It Take" scenario to reduce emissions 50 percent by 2030);
- Examples of how COG and local jurisdiction efforts that can support implementation (it's not an exhaustive list); and
- How the action benefits other *Region Forward* goals.

Table 2 is a summary of the climate action areas and priority collaborative actions described in this strategy. While these actions focus on what the Climate, Energy and Environment Policy Committee (CEEPC) members can do together to move the region towards the 50 percent by 2030 goal, other bodies at COG are also implementing action that support GHG emission reduction. After the action descriptions, this section includes a summary of regional transportation and land use planning efforts that also address climate change.

Table 2: Metropolitan Washington Priority Collaborative Mitigation Actions

Climate Action Area	Action ID	Priority Collaborative Action
Planning	PL - 1	Advance Climate Planning and Track Progress
Equity	EQ - 1	Enable Equitable Planning Practices
	EQ - 2	Prioritize Sustainable Energy Access for All
Clean Electricity	CE - 1	Advocate for Aggressive Renewable Portfolio Standards
	CE - 2	Accelerate Development of On-Site Renewables
	CE - 3	Accelerate Deployment of Battery Storage
	CE - 4	Accelerate Development of Microgrids for Critical Infrastructure
	CE - 5	Accelerate Development of Large-Scale Off-Site Renewables
	CE - 6	Advocate for and Implement Community Choice Aggregation
Zero Energy Buildings	ZEB - 1	Expand Building Benchmarking Requirements
	ZEB - 2	Accelerate Deep Building Retrofits
	ZEB - 3	Enhance Green Building Codes and Policies to Facilitate Net Zero Energy Building Development

	ZEB - 4	Expand Proper Disposal and Leak Detection of Refrigerants
Zero Emission Vehicles	ZEV - 1	Expand Light-Duty Electric Vehicle Deployment
	ZEV - 2	Accelerate Electrification of Medium- and Heavy-Duty Vehicles
	ZEV - 3	Build Out Regional Electric Vehicle Charging Network
Zero Waste	ZW - 1	Implement Curbside Organics Recycling Programs
	ZW - 2	Reduce Solid Waste Generation
	ZW - 3	Build Markets for Circularity
Sequestration	SQ - 1	Strategically Plant New Trees on Publicly Owned Land
	SQ - 2	Enhance Regulatory Capacity to Manage Tree Canopy and Forest Protection
	SQ - 3	Enhance Tree Planting and Preservation on Privately Owned Lands

PL-1: ADVANCE CLIMATE PLANNING AND TRACK PROGRESS

Action Overview

Local jurisdictions play a central role in the global effort to reduce GHG emissions. Climate action planning provides local jurisdictions with the direction needed to achieve the overarching vision and goals for the community while also curbing GHG emissions. The United Nations states that climate action plans should be ambitious, inclusive and fair, comprehensive and integrated across sectors, relevant and actionable, evidence-based, transparent and verifiable. Conducting GHG inventories is an important part of measuring changes over time to track progress toward goals.[xxvii]

The City of Bowie develops climate action plans in 5-year intervals and tracks progress annually. Bowie's Vision for 2030 includes GHG emission to be 50 percent below 2015 levels, more than half of energy consumption comes from renewables and one-third of privately owned vehicles are electric. Government action is being led by an intergovernmental Sustainability Staff Team and community action is led by a Mobilization Team comprised of a diverse group of community leaders. COG develops the City's community-scale inventories to track progress toward the plan's goals.[xxviii]

Supporting Overall GHG Reduction Goal

With more than 90 percent of total GHG emissions in the region associated with the built environment and transportation, implementation of plans to reduce emissions from these sectors have the potential to significantly reduce emissions. Local jurisdictions and the region cannot monitor progress if it is not measured; therefore, GHG inventories are an important piece of supporting GHG emission reduction goals.

Level of Implementation Needed to Reach Overall GHG Goal:

Developing and implementing equity-focused climate plans and tracking progress through GHG inventories lays the foundation for reducing GHG emissions 50 percent below 2005 levels by 2030.

How COG Can Support

- Complete GHG emission inventories at milestone dates to measure local and regional progress. Follow and help advance U.S. and global best practices for inventories.
- Develop and incorporate net emissions, from sources such as forests/trees and renewable procurement, in COG inventory work to better track progress toward carbon neutrality.
- Update GHG Contribution Analyses for new inventory years to evaluate what is driving GHG change across the region.
- Support jurisdictions in climate planning initiatives, including equitable climate policy, program and decision-making processes.
- Support tracking of local and regional goals, plans, and progress. Share and encourage best practices.

How Member Jurisdictions Can Support

- All COG member jurisdictions should adopt GHG emission reduction goals.
- All COG member jurisdictions should adopt climate/energy plans.
- Adopt climate emergency policies.
- Review COG community-scale inventory work and modify local results, where appropriate. Conduct local government operations inventories.
- Educate public on GHG impacts to the community and engage community in equitable solutions.

Region Forward Co-Benefits:

- **Equity:** Engage all parts of the community in climate planning initiatives. COG Equity Emphasis Areas can be leveraged as a resource for equitable engagement opportunities.

EQ-1: ENABLE EQUITABLE PLANNING PRACTICES

Action Overview

Integrating equity into all components of planning practices is critical to ensuring that climate policies and programs address the concerns of all community members, particularly those in underserved communities. Underserved communities have been disproportionately impacted by environmental exposures, including ambient air pollution and climate-change-related health impacts. This trend will continue unless planning processes at all levels of government make addressing these historical inequities central to climate change decision-making processes.[xxix]

To support communities looking for guidance on best practices for incorporating equity considerations in planning processes, COG released the Environmental Justice Toolkit (EJ Toolkit) in 2017. The EJ Toolkit is intended to be a resource on government measures, practices, and policies aimed at creating cooperative solutions to issues of fair and just treatment and equitable access in the development, application, and enforcement of environmental policies.[xxx]

Supporting Overall GHG Reduction Goal

Achieving the region's overall GHG emissions reduction goals will not be possible without the implementation of equitable planning processes that fully integrate the concerns and needs of disadvantaged communities. Engaging and activating these communities will be critical to achieving these goals.

Level of Implementation Needed to Reach Overall GHG Goal:

In order to meet the overall GHG reduction goal, equity will need to be a central component of planning practices for all member jurisdictions.

How COG Can Support

- Continue to support local jurisdictions on racial equity planning and integrating climate planning within this context.
- Continue to identify and share tools, datasets, and resources, such as Equity Emphasis Areas and the Environmental Justice Toolkit, to help jurisdictions define what equity means in their local context and engage underserved communities.[xxxi]
- Continue to share best practices through regional meetings and materials on how to perform equitable engagement and planning processes and how to design climate action equitably.

How Member Jurisdictions Can Support

- Develop an equity plan that incorporates addressing climate impacts to vulnerable populations.
- Develop a process for mainstreaming equitable community engagement during climate and energy projects and planning processes.
- Provide accessible and meaningful engagement opportunities for underserved communities and develop a shared understanding of community needs.
- Support community leadership development in underserved communities.
- Provide data, information, and resources to underserved communities and engage community members in citizen science so they are a part of developing relevant data for their community.

Region Forward Co-Benefits:

- **Economy:** Equitable advancement of the clean economy includes supporting green job training programs and providing economic benefits to disadvantaged communities through investment in green infrastructure and sustainable housing.
- **Health and Human Service**s: With a more equitable approach to planning, some health and climate risks can be addressed in underserved communities that experience the highest risk.

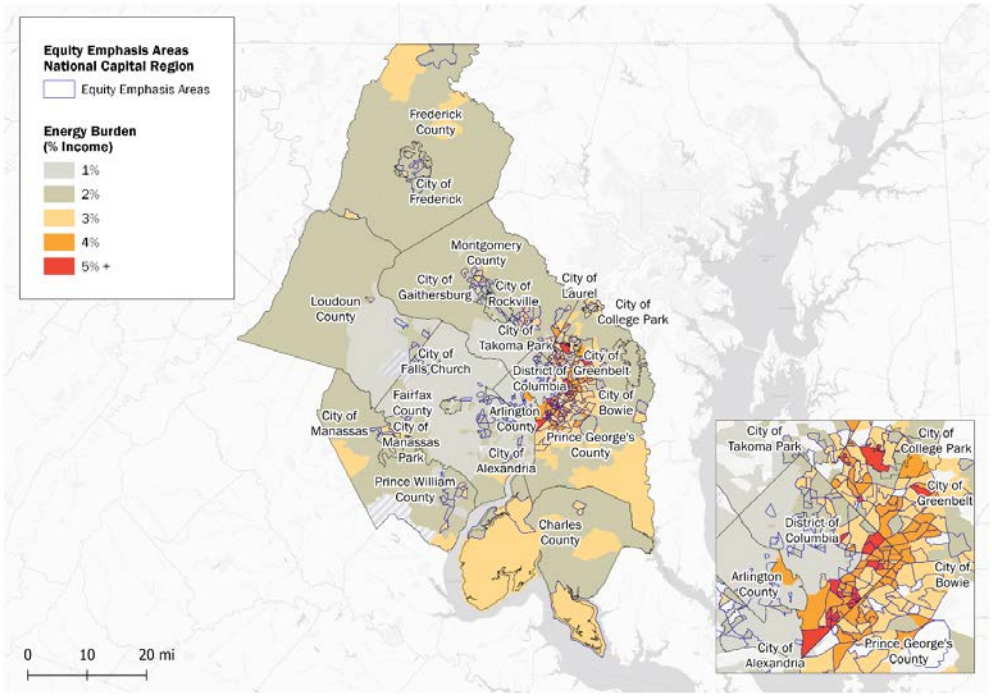
EQ-2: PRIORITIZE SUSTAINABLE ENERGY ACCESS FOR ALL

Action Overview

Ensuring that all residents and local businesses have access to sustainable and affordable energy is key to reducing GHG emissions while simultaneously ensuring that underserved communities are well positioned to achieve economic stability and improve their overall quality of life. Historically, there have been significant disparities in renewable energy deployment based on race and ethnicity. For example, even when adjustments for household income and homeownership rates are made, black and Hispanic residents are significantly less likely to install and reap the cost savings benefits of rooftop solar photovoltaics (PV) systems. [xxxii]

Overall "energy burden," or the percentage of household incomes that goes towards energy costs, is also a significant concern for underserved communities. Across the region, underserved communities spend a larger portion of income on home energy cost than other residents. Figure 7 shows that mean energy burden across census tracts in Equity Emphasis Areas (EEAs) is 6.6 percent higher than all other census tracts in the region. Metropolitan Washington EEAs, identified by COG and its members, include communities that have a higher than average concentration of low-income, minority populations, or both. Ensuring equitable energy access to underserved communities ensures energy burdens don't limit residents' ability to choose between paying energy bills or living essentials.[xxxiii]

Figure 7: Equity Emphasis Areas and Energy Burden



Source: US Department of Energy Low-Income Energy Affordability Data (LEAD) Tool and COG Equity Emphasis Areas

Jurisdictions can enact policies and programs that aim to increase access to sustainable energy and reduce energy burden. For example, D.C.'s Solar for All program, established in 2016, aims to provide 100,000 low-to-moderate income families with the benefits of locally generated clean energy and help reduce their energy bills 50 percent by 2032. The program is funded through the District's Renewable Energy Development Fund. At the state level, Maryland's community solar program has a low-income "carve-out," meaning that about 125 megawatts (MW) of the total 418 MW statewide cap is set aside for projects focused on low- and moderate-income customers. The carve-out increases the attractiveness of these projects to potential developers and increases the overall likelihood that these projects will be built.[xxxiv]

Supporting Overall GHG Reduction Goal

Investing in the deployment of solar PV and energy efficiency improvements in underserved communities has the potential to both decrease the emissions associated with electricity consumption and reduce total energy consumption associated with buildings in these areas. Since over 35 percent of total GHG emissions in the region are associated with the electricity consumption, increasing access to sustainable and affordable energy has significant potential to reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

Increasing deployment of on-site renewables in underserved communities will be critical to reaching the overarching target of 3.4 percent of total electricity supply being provided by on-site solar PV by 2030.

How COG Can Support

- Identify priority populations or areas that are energy burdened and could benefit most from solar PV investment and energy efficiency improvements.

How Member Jurisdictions Can Support

- Develop and implement energy efficiency and renewable energy programs for low income households.
- Engage with underserved communities to identify a shared understanding of community needs and share available resources for building energy improvement programs and incentives.
- Support clean energy economy and workforce development in underserved communities.

Region Forward Co-Benefits:

- **Economy**: Low-income populations in the region are disproportionately burdened by the cost of energy and are least likely to have the capital or support to upgrade their homes to be more energy efficient. A focus on supporting these communities will reduce costs while reducing regional GHG emissions.
- **Health and Human Services**: Energy bills can be highest in the summer as temperatures rise and cooling demand increases. With reduced energy cost burdens, lower income households may be able to afford to run cooling equipment throughout the summer, protecting occupants from extreme heat and the associated health risks.

CE-1: ADVOCATE FOR AGGRESSIVE RENEWABLE PORTFOLIO STANDARDS

Action Overview

A Renewable Portfolio Standard (RPS) is a regulatory measure that requires a certain proportion of the state's energy to come from renewable sources including solar, wind, and other alternatives to fossil fuel electricity generation. It is the most successful method of increasing the amount of renewable electricity generated within a grid system and drives greater deployment of renewable energy projects.[xxxv]

In 2018, the District of Columbia updated its RPS, requiring 100 percent of electricity sales to come from renewable energy sources by 2032 with a 10 percent solar carveout by 2041. In 2019, Maryland updated its RPS, requiring 50 percent of electricity sales in the state to come from renewable sources by 2030. It also includes a solar carveout of at least 14.5 percent by 2030, and at least 1,200 MW of offshore wind by 2030. In 2020, Virginia passed the Clean Economy Act, which requires that 100 percent of electricity sales in the state comes from renewable sources by 2045 or 2050 (depending on the utility classification). This is a significant increase from the state's previous RPS, which only established a voluntary 15 percent RPS goal by 2025.[xxxvi]

Supporting Overall GHG Reduction Goal

Carbon-intensive fossil fuels remain responsible for a significant percentage of total electricity generation provided to the regional grid. In 2015, utility supplied renewable energy in metropolitan Washington made up over 8 percent of electricity sales that year. With aggressive RPS goals, this percentage will grow significantly in the coming decades With 36 percent of total GHG emissions in the region associated with electricity consumption, state RPS programs that accelerate the deployment of renewable energy on the region's grid is crucial for reducing GHG emissions.[xxxvii]

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, states and utilities are able to continue adding renewable generation capacity to achieve the following percentages of renewable energy in terms of overall grid mix: Washington D.C. (87 percent), Maryland (50 percent), and Virginia (35 percent).

How COG Can Support

- Continue to support strong state-level RPS and encourage REC markets.
- Encourage solar carve-outs in RPS policies to support solar project development in the region.

How Member Jurisdictions Can Support

- Continue to support strong state-level RPS and encourage REC markets.

Region Forward Co-Benefits:

- **Economy:** RPS sends a signal to utilities and businesses to increase renewable energy investment.
- **Health and Human Services**: By decreasing market demand for fossil-fuel electricity generation technologies, RPS can decrease criteria air pollutants and associated adverse health impacts.

CE-2: ACCELERATE DEVELOPMENT OF ON-SITE RENEWABLES

Action Overview

On-site renewable energy systems can both reduce electricity costs for local residents and businesses and increase the percent of renewable electricity supplied to the regional grid. Local governments have several tools available for increasing the capacity of renewables installed in their communities including directly installing renewables on government facilities, mandating or incentivizing renewables on newly constructed buildings in the community, implementing solar co-ops, and meeting EPA Green Power Partnership (GPP) requirements.

A number of local governments have installed solar on municipal buildings, including the District of Columbia, Montgomery County, Prince George's County, the City of Bowie, and others. Solarize NoVA is a community-based outreach initiative sponsored by the Northern Virginia Regional Commission (NVRC) that facilitates the deployment of solar energy to homes and businesses in Northern Virginia. Through bulk purchasing and free solar site assessments, they have played a prominent role in more than 370 solar energy systems installed in Northern Virginia, totaling 3.9 megawatts of capacity.[xxviii]

Supporting Overall GHG Reduction Goal

Carbon-intensive fossil fuels remain responsible for a significant percentage of total electricity generation provided to the regional grid. On-site renewable installations help to reduce the region's reliance on these fossil fuel resources. With 36 percent of total GHG emissions in the region associated with electricity consumption, local policies and programs to accelerate the deployment of on-site renewables have the potential to significantly reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, on-site renewables will account for 2 percent of total electricity supply in the region. This is equivalent to needing 200,000 more rooftop solar systems.

How COG Can Support

- Support member jurisdictions:
  - Adopt solar-ready new construction ordinances or incentive programs;
  - Form and operate solar cooperatives and support associated solar mapping effort; and
  - Install renewable energy systems on schools and municipal infrastructure.
- Provide clean energy feasibility assessments at key facilities (campuses, hospitals, etc.).

How Member Jurisdictions Can Support

- Establish residential and commercial new construction ordinances or incentives that require the installation of solar or solar-ready construction to enable solar installation at a later date.
- Provide or promote incentives to encourage installation of solar in the community.
- Form new or expand existing solar cooperatives.
- Install renewable energy systems on all new and existing municipal buildings and facilities.
- Achieve and maintain EPA GPP at government operations and community levels.

Region Forward Co-Benefits:

- **Economy and Equity**: On-site renewable systems can reduce the financial burden associated with energy costs. Incentives and cooperative campaigns can be designed to maximize participation rates among economically disadvantaged communities.
- **Public Safety**: When paired together, on-site renewable systems and battery storage systems have the potential to supply electricity during grid outages and add to grid resilience by decreasing peak loads and stress on the distribution system.

CE-3: ACCELERATE DEPLOYMENT OF BATTERY STORAGE

Action Overview

Battery storage deployment supports renewable energy as it has the capability of reliably supplying renewable energy to the grid when there is high demand. One of the main barriers to renewable energy being widely adopted has been the challenge of on-demand operation and providing a "baseload" of power to the grid. When renewables are deployed with battery storage, energy load reliability is dramatically improved. An additional benefit of battery storage deployment is that it boosts the resilience of facilities where it is deployed.[xxxix]

Virginia's Grid Transformation & Security Act of 2018 allows Dominion Energy to invest in up to 30 megawatts of battery storage pilot projects. In 2020, Dominion has had four battery storage pilot projects approved, which will pave the way for additional energy storage technology projects needed to support the company's commitment to achieve net zero carbon and methane emissions by 2050, increase renewable energy deployment and improve grid reliability.[xl]

Supporting Overall GHG Reduction Goal

Carbon-intensive fossil fuels remain responsible for a significant percentage of total electricity generation provided to the regional grid. Battery storage deployment reduces the region's reliance on these fossil fuel resources, while bolstering the region's resilience. With 36 percent of total GHG emissions in the region associated with electricity consumption, local policies and programs to accelerate the deployment of battery storage have the potential to support significant GHG emissions reductions.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, to realize the full emission reduction and grid stabilization potential of on-site solar photovoltaics (PV) installed across the region, approximately 10 percent of PV installations will need to be paired with battery storage systems.

How COG Can Support

- Support state and national incentives and opportunities that enhance battery storage deployment in the region.
- Identify on-site and grid-scale battery storage deployed in the region.
- Partner on grant applications or provide contract support for project planning and implementation support.

How Member Jurisdictions Can Support

- Advocate for utility-scale battery storage deployment.
- Implement battery storage pilot initiatives at public facilities.
- Provide or promote incentives to community for energy storage systems.
- Incorporate community energy infrastructure needs, goals, and strategies in master plans, comprehensive plans, and small area plans.

Region Forward Co-Benefits:

- **Economy and Equity**: Battery storage programs and incentives has the potential to provide cost savings to local governments, businesses and economically disadvantaged. Accelerating battery storage installations also has the potential to create high quality jobs in the region.
- **Public Safety**: Battery storage has the potential to supply electricity during grid outages and add to grid resilience for critical facilities (e.g. hospitals, schools, nursing homes) and in underserved communities.

CE-4: ACCELERATE DEVELOPMENT OF MICROGRIDS FOR CRITICAL INFRASTRUCTURE

Action Overview

A microgrid is a localized energy grid with its own control system, allowing it to disconnect from the traditional grid and operate autonomously, as well as connect to the grid and act as a distributed power resource. Microgrids can provide a form of energy resilience and independence for local residents and businesses due to their ability to "island" from the larger grid. This is especially important for critical infrastructure when energy is needed during blackouts or other interruptions in service. Additionally, microgrids can provide a way to secure energy access to vulnerable populations.[xli]

Montgomery County has installed a microgrid project at the County's Public Safety Headquarters, as part of a comprehensive effort to ensure the resiliency of critical public services during major electric distribution system outages. The project includes multiple clean energy technologies, which will reduce GHG emissions by 5,900 metric tons annually. Montgomery County has also installed a microgrid at the County's Correctional Facility, which will reduce GHG emissions by 950 tons annually.[xlii]

Supporting Overall GHG Reduction Goal

Microgrids provide resilience through their localized power sources. These power sources are largely renewable and are often combined with energy storage systems. This reduces reliance on the larger grid, which provides a significant power from carbon-intensive fossil fuels. With 36 percent of total GHG emissions in the region associated with electricity consumption, greater numbers of microgrids has the potential to significantly reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

Development of microgrids at critical facilities like schools and hospitals will help the region achieve needed 2030 implementation levels for on-site renewable energy and battery storage and improve overall resilience.

How COG Can Support

- Support the identification and selection of critical infrastructure for microgrid implementation.
- Partner on grant applications or provide contract support for project planning, feasibility, and implementation support.
- Support state incentives and opportunities to help facilitate microgrid deployment.
- Coordinate with members and partners to reduce barriers to deployment.

How Member Jurisdictions Can Support

- Assess feasibility of and implement microgrids at critical infrastructure.
- Coordinate with utilities and critical infrastructure partners to deploy microgrid solutions that support potentially vulnerable populations and underserved communities.

Region Forward Co-Benefits:

- **Public Safety and Equity**: Microgrids have the potential to supply electricity during grid outages and add to grid resilience for most critical facilities (e.g. hospitals, schools, nursing homes) and in underserved communities.
- **Education**: Schools present great opportunity for microgrids and add renewable energy to schools, increase resilience and help to educate students and community members on benefits of microgrids.

CE-5: ACCELERATE DEVELOPMENT OF LARGE-SCALE, OFF-SITE RENEWABLES

Action Overview

Large-scale, off-site renewable energy systems can reduce electricity costs for local governments, businesses and residents while increasing the percent of renewable electricity supplied to the regional grid. Power purchase agreements (PPAs) are the main vehicle for providing large-scale renewable energy to the grid. A PPA is an arrangement between a third-party developer, who installs, owns, and operates an energy system on a customer's property; and the customer, who purchases the system's electricity. Additionally, a renewable energy credit (REC) is an instrument that can be used to substantiate renewable energy claims. RECs represent the rights to environmental, social, and other non-power attributes of renewable energy.[xliii]

At the end of 2019, Fairfax County announced contracts with multiple solar PPA service providers, which will allow for the installation of solar arrays at government, school, and park sites. This initiative is the largest of its kind in Virginia to date and has the potential to save the County more than $60 million in electricity costs, while supporting the County's greenhouse gas reduction goals. Similarly, Frederick County entered into a PPA with Tesla for a solar array on the County's landfill.[xliv]

Supporting Overall GHG Reduction Goal

Carbon-intensive fossil fuels remain responsible for a significant percentage of total electricity generation provided to the regional grid. With 36 percent of total GHG emissions in the region associated with electricity consumption, local governments have the potential to significantly reduce emissions through PPAs for renewable energy. This expands the delivery of renewable energy to government facilities, as well as local businesses and other stakeholders seeking to procure more renewable energy.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, 9.5 percent of total electricity supplied in the region will need to come from 100 percent renewable electricity procured through contractual instruments, including PPAs and RECs. This 9.5 percent of renewables will be achieved through a combination of Community Choice Aggregation (CCAs) and PPAs and RECs outside of CCAs.

How COG Can Support

- Examine the possibility of regional demand aggregation.
- Attempt cooperative purchasing initiatives or energy purchasing consortia.

How Member Jurisdictions Can Support

- Establish PPA(s) to provide clean electricity to local government facilities, potentially aggregating demand with other local jurisdictions or large local businesses to reduce cost.
- Encourage large, local businesses to investigate PPAs.

Region Forward Co-Benefits:

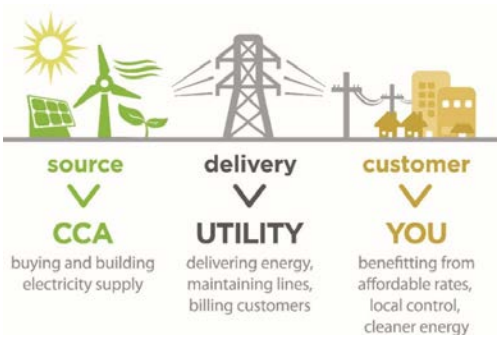
- **Economy and Equity**: The are potential cost savings to local governments, businesses, and economically disadvantaged, if they are sought out in PPA partnerships. Accelerating large-scale solar installations also has the potential to create high quality jobs in the region.
- **Health and Human Services**: By decreasing market demand for fossil-fuel electricity generation technologies, CCAs can decrease criteria air pollutants and associated adverse health impacts.

CE-6: ADVOCATE FOR AND IMPLEMENT COMMUNITY CHOICE AGGREGATION

Action Overview

Community Choice Aggregation (CCA) – sometimes referred to as Municipal Aggregation or Community Choice Energy - programs enable local governments to pool the electricity load of residents and businesses within the community and procure electricity on their behalf (Figure 8). CCAs provide local jurisdictions with greater control over their electricity generation mix and the opportunity to increase the percentage of renewables within the mix at potentially lower energy prices. Additionally, CCA programs can provide a platform for increasingly advanced methods for supplying customers with renewable electricity and investing in local distributed energy projects.[xlv]

Figure 8: How Community Choice Aggregation Works



In March 2020, the Maryland House of Delegates passed HB 561 that sets the path for allowing Montgomery County to establish CCA pilot program, potentially opening the door for additional CCAs across the state. Virginia Code § 56-589 allows municipalities in the state to establish CCAs.[xlvi]

Supporting Overall GHG Reduction Goal

Because CCAs enable local jurisdictions to determine the percent of electricity from renewable sources supplied to residents and businesses, they have the potential to significantly reduce electricity emissions, which account for 36 percent of the region's total GHG emissions. Most CCAs operate on an "opt-out" basis, meaning residents and businesses are automatically enrolled in the program with the option to not participate. This leads to high participations rates, furthering their GHG emissions reduction potential.

Level of Implementation Needed to Reach Overall GHG Goal:

In addition to state-level RPS requirements and renewable electricity generated on-site, an additional 9.5 percent of total electricity supplied in the region will need to come from 100 percent renewable electricity by 2030 procured through contractual instruments, including PPAs and RECs.

How COG Can Support

- Advocate for policies to help overcome barriers to CCA adoption in Maryland and Virginia.
- Leverage COG Cooperative Procurement Program to fast-track local implementation.

How Member Jurisdictions Can Support

- Advocate for State policy to support authorization of CCAs and reduce barriers to CCA adoption.
- Implement and share best practices from CCA pilot programs, where applicable

Region Forward Co-Benefits:

- **Economy and Equity**: CCAs have the potential to lower electricity costs to residents and businesses, helping to reduce economic disparities and make the economy more competitive.[xlvii]
- **Health and Human Services:** By decreasing market demand for fossil-fuel electricity generation technologies, CCAs can decrease criteria air pollutants and associated adverse health impacts.

ZEB-1: EXPAND BUILDING BENCHMARKING REQUIREMENTS

Action Overview

Benchmarking programs applicable to municipal, commercial, and multifamily buildings enable building managers to measure the energy efficiency of their building against comparable buildings from across the region and identify buildings that could benefit most from energy efficiency improvements. Benchmarking programs can be voluntary or mandatory, include energy and/or water consumption, and can be customized by square footage and building type.

The vast majority of building benchmarking ordinances rely on the use of the EPA's ENERGY STAR Portfolio Manager, a free online benchmarking tool that helps building managers track data and measure progress using a 1-100 ENERGY STAR scoring system. Both Washington D.C. and Montgomery County have enacted benchmarking ordinances that apply to commercial and multifamily buildings over 50,000 square feet and to buildings owned and operated by the jurisdiction. Although Virginia State law currently prohibits mandatory benchmarking ordinances, Arlington County benchmarks and discloses all County facilities and has offered support, training, energy challenges, and incentives for commercial and multi-family buildings.[xlviii]

Supporting Overall GHG Reduction Goal

Through the identification of inefficient buildings, a benchmarking ordinance can be effective in driving increased participation in existing energy audit and efficiency programs. Since over 24 percent of total GHG emissions in the region are associated with commercial and municipal buildings, there is significant potential to reduce emissions from benchmarked buildings.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, assuming 30 percent of buildings receiving deep energy retrofits have been benchmarked, approximately 117 million square feet of multi-family and commercial space will need to have been benchmarked.

How COG Can Support

- Share best practices and lessons learned from existing benchmarking programs and provision of materials including policy/program implementation and resource guides.
- Advocate for legislation in Virginia to enable jurisdictions to adopt benchmarking ordinances.

How Member Jurisdictions Can Support

- Develop and implement or expand government operations building benchmarking initiatives (applicable in MD, VA, DC).
- Develop and implement or expand community commercial and multifamily building benchmarking ordinances (applicable in MD, DC) or provide financial or development incentives (such as floor-to-area ration, streamlined permitting, tax incentives, etc.) to buildings that agree to annual benchmarking (applicable in MD, VA, DC).
- Utilize benchmarking program as a mechanism to drive increased participation in existing government or utility energy audit and energy efficiency incentive programs.
- Promote voluntary benchmarking for commercial and multifamily buildings through marketing and outreach campaigns, providing guidance, technical support and promoting cost savings.

Region Forward Co-Benefits:

- **Environment**: Benchmarking programs can also help to identify buildings that use water inefficiently and preservation of water resources remains a *Region Forward* priority.
- E**conomy and Equity**: Benchmarking programs leading to more energy efficient multifamily and commercial buildings reduce the financial burden associated with energy costs.

ZEB-2: ACCELERATE DEEP BUILDING RETROFITS

Action Overview

Deep energy retrofits aim to reduce energy consumption in buildings by at least 50 percent by taking a systems-thinking approach that evaluates interactions between different components of a building. Deep retrofit improvements include improvements to the building envelope through additional insulation, air sealing, and window replacements and upgrades to or replacements of inefficient heating, cooling, and hot water systems.

While deep retrofits result in higher cost savings, they also require higher up-front cost. For this reason, it is critical to provide attractive financing options to property owners through programs such as Commercial Property Assessed Clean Energy Financing (C-PACE), green banks, state and utility energy efficiency incentives, and programs tailored to retrofit low-income housing. All of these types of financing options exist in the region. More than 10 PACE Programs have been launched and 35 projects in the region have been financed thus far by C-PACE programs. The District of Columbia and Montgomery County have established green banks. Arlington Energy Masters is a program focused on low-income retrofits. Expanded participation in existing programs and new programs, particularly targeting low-income residents and businesses, are needed to accelerate retrofits.[xlix]

Supporting Overall GHG Reduction Goal

By addressing financial barriers to capital-intensive deep energy retrofits, C-PACE and green banks can be effective in significantly reducing heating and cooling loads of commercial, municipal, and residential buildings. Since more than half of all GHG emissions in the region are associated with the built environment, deep energy retrofits have significant potential to reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

Annually, 2 percent of all residential and commercial buildings will need to receive a deep retrofit to support the region in meeting the 2030 GHG emission reduction goals.

How COG Can Support

- Provide technical guidance and support to assist local jurisdictions in expanding participation in existing and new energy efficiency programs.
- Facilitate regional sharing of net zero energy code language for building retrofits.

How Member Jurisdictions Can Support

- Retrofit existing public facility(ies) to net zero energy.
- Offer innovative energy financing solutions for residential or commercial sectors (e.g. green bank, PACE, loan loss reserves, etc.).
- Promote state and utility incentives and technical assistance for residential and commercial deep energy retrofits. Consider supplementing with local incentives.
- Expand programs that implement deep energy improvements in affordable housing.

Region Forward Co-Benefits:

- **Environment**: Energy efficiency programs can also help to identify buildings that use water inefficiently.
- **Economy and Equity**: Improving the energy efficiency reduces the financial burden associated with energy costs for both residents and local businesses. Accelerating retrofit work also has the potential to create high quality jobs in the region.
- **Health and Human Services**: Green buildings with enhanced ventilation help to increase indoor air quality, reduce illness, and improve productivity.[l]

ZEB-3: ENCHANCE GREEN BUILDING CODES AND POLICIES TO FACILITATE NET ZERO BUILDING DEVELOPMENT

Action Overview

Green building codes are laws established by states or local jurisdictions applying to newly constructed buildings or major renovations that mandate increased levels of energy efficiency and often include a requirement for the inclusion of on-site renewable energy systems. Green building codes can help to accelerate the adoption of net zero buildings – those that produce as much energy as they use - across the region.

Maryland, Virginia, and the District of Columbia have all adopted building codes that incorporate energy efficiency components outlined in the International Energy Conservation Code (IECC) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) standards. While local jurisdictions in Maryland are permitted to pass more stringent codes that exceed state minimum standards ("stretch codes"), local jurisdictions in Virginia are not. Member jurisdictions in Maryland, including Montgomery County and City of Rockville, have a history of adopting codes that are more stringent than those required by the state. Currently, Montgomery County is in the process of adopting the 2018 International Green Construction Code (IGCC). [li]

Supporting Overall GHG Reduction Goal

Adopting more stringent building codes, both at the state and local level, can be effective in significantly reducing the total energy consumption and increasing the level of on-site renewable energy generation of commercial, municipal, and residential buildings. Since half of all GHG emissions in the region are associated with the built environment, green building codes have significant potential to reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

All jurisdictions will need to implement building codes that require net zero energy standards in new construction by 2030, through either adoption of local stretch codes or compliance with potential future state requirements that mandate net zero construction.

How COG Can Support

- Convene technical experts and facilitate information exchange that enable creation of policies and programs and address barriers to action.
- Coordinate local government input to the national model energy code development process.
- Encourage adoption of building codes and incentives to facilitate net zero building construction.

How Member Jurisdictions Can Support

- Participate in the national energy code development process.
- Adopt policy for all new local public facilities to be net zero energy.
- Adopt net zero energy codes or incentives for private development.
- Include net zero energy goals and strategies in master, comprehensive, and small area plans.
- Establish a net zero energy building district or portfolio.[lii]
- Provide education and training on new and advanced green construction standards.

Region Forward Co-Benefits:

- **Environment**: Building codes can be designed to address both energy and water efficiency.
- **Health and Human Services**: Green buildings with enhanced ventilation help to increase indoor air quality, reduce illness, and improve productivity.[liii]
- **Public Safety**: As net zero building codes continue to deemphasize reliance on natural gas in new construction, the risks associated with natural gas leaks and explosions will decrease.

ZEB-4: EXPAND PROPER DISPOSAL AND LEAK DETECTION OF REFRIGERANTS

Action Overview

Refrigerants are chemicals found in a variety of building equipment – including air conditioners, refrigerators, and freezers – that absorb and release heat to enable chilling. Refrigerant gasses are a significant source of GHG emissions because of their high global warming potential (GWP).

The Kigali Amendment to the Montreal Protocol is an international agreement between 99 countries and the European Union to gradually reduce the consumption and production of hydrofluorocarbons (HFCs), the group of chemicals most commonly used today for refrigeration. The United States has not ratified the Kigali Amendment. In the absence of federal regulations, Maryland and Virginia have taken action. In 2020, Maryland Department of Environment proposed regulations to reduce use of HFCs 25 percent by 2030 and Virginia approved a law requiring its Air Pollution Control Board to adopt HFC restrictions modeled after the EPA's Significant New Alternative Policy (SNAP) Rules that were overturned by a federal court in 2017.[liv]

Supporting Overall GHG Reduction Goal

Advocating for increasingly aggressive state policies, educating private businesses on refrigerant management best practices, and adopting these same best practices in government operations can significantly reduce emissions associated with refrigerant leaks. A small yet growing portion of total GHG emissions in the region are associated with refrigerants and advancing refrigerant policies and best practices has significant potential to reduce these emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, refrigerant emissions will need to be reduced by 66 percent through a combination of 1) Leak detection and related upgrades to systems like refrigerators and HVAC systems, and 2) A phase out of high-GWP HFCs at the state level.

How COG Can Support

- Share best practices through regional meetings and materials (fact sheets, resource guides etc.).
- Organize advocacy efforts to help advance legislation at state and district level restricting the use of HFCs.
- Develop education on proper handling, disposal, and leak detection for high GWP refrigerants from coolers, air conditioners, and other appliances.

How Member Jurisdictions Can Support

- Support advocacy efforts.
- Institute best practices in refrigerant management in government operations, including leak detection and monitoring, leak reporting, reporting and record keeping and retrofitting or retiring older systems.
- Promote awareness and climate impacts of proper disposal techniques and refrigerant management best practices.

Region Forward Co-Benefits:

- **Economy and Equity**: Many upgrades to reduce refrigerant leakages also improve the overall energy efficiency of equipment. Accelerating the detection of leaks and retrofitting of equipment would help these businesses save money and also create high quality refrigerant technician jobs.
- **Public Safety**: Leaks of some refrigerants, including freon, pose a serious health risk.

ZEV-1: EXPAND LIGHT-DUTY ELECTRIC VEHICLE DEPLOYMENT

Action Overview

A number of barriers are currently preventing the adoption of light-duty electric vehicles (EVs), including vehicle cost, limited number of models available, lack of consumer awareness, long charging times and the lack of capable charging infrastructure. However, as EV technology advances and the EV market matures, these obstacles are breaking down. The cost of EVs are decreasing as battery prices continue to decline, the number and range of available models is increasing as manufacturers become more heavily invested in EV development, and the speed of charging continues to increase with the expanded deployment of level 2 and DC fast charging stations.[lv]

Continuing to overcome these barriers will be critical to rapidly increasing the number of EVs on the road and will require action at the state, regional and local levels. Several local jurisdictions have taken steps to electrify government fleets. For example, Montgomery County has purchased 39 battery electric vehicles (BEVs). Also, Alexandria has committed to the purchase of only electric of hybrid gas/electric general purpose sedans and is undertaking a pilot to test the feasibility of electric and hybrid police cruisers.[lvi]

Supporting Overall GHG Reduction Goal

Light-duty on-road vehicles are responsible for 60 percent of transportation emissions in the region. As the regional electricity supply continues to increasingly rely on renewable sources of generation, the emission reduction potential of EVs compared to internal combustion vehicles continues to increase. With 24 percent of total GHG emissions in the region generated by light-duty, fossil fuel on-road vehicles, local policies and programs to accelerate the adoption of EV passenger vehicles have the potential to significantly reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, of the approximately 4.1 million light duty vehicles on the road in the region, 34 percent or 1.4 million of those vehicles will need to be battery electric (BEV) or plug-in hybrid-electric (PHEV).

How COG Can Support

- Support aggregation of demand via COG Cooperative Purchasing Program and local EV buying coops. Coordinate closely with Clean Cities, Washington Area New Dealers Association (WANADA), and electric EV supply equipment (EVSE) industry.
- Advocate for state and national incentives for purchasing EVs.

How Member Jurisdictions Can Support

- Implement community-wide EV buying co-ops.
- Promote state and national incentives for purchasing EVs.
- Adopt green fleet policy or fleet management plan to transition fleets to zero emission vehicles and participate in cooperative procurement opportunities for public fleets.

Region Forward Co-Benefits:

- **Economy and Equity**: Fuel and maintenance cost savings associated with EVs, combined with battery production prices continuing to drop, have the potential to make EVs a more cost-effective option compared to internal combustion vehicles. Programs and policies to promote EV ownership should prioritize disadvantaged communities.[lvii]
- **Health and Human Services**: Use of gasoline, and particularly diesel, to power passenger vehicles is a major cause of criteria air pollutants and associated adverse health impacts. EVs, which release no tailpipe emissions, can help to significantly reduce local air pollution.

ZEV-2: ACCELERATE ELECTRIFICATION OF MEDIUM- AND HEAVY-DUTY VEHICLES

Action Overview

In recent years, light-duty electric vehicles have achieved significant market penetration. However, electrification of medium- and heavy-duty vehicles (MHDVs) remains in the early phases and technological advancements are needed for electric MHDV to be deployed at scale. By electrifying MHDV public fleets and working collaboratively with private fleets to pursue fleet electrification, COG member jurisdictions and regional partners can advance electric MHDVs in the region.[lviii]

Bolstered by significant levels of federal and state funding, busses are one application where MDHV electrification has made progress. In 2020, 15 states, including Maryland, and the District of Columbia announced a joint memorandum of understanding committing to work collaboratively to accelerate the market for electric MHDVs with the goal of ensuring that 100 percent of new MHDV sales be zero emissions by 2050, with an interim goal of 30 percent by 2030. Local transit agencies including the D.C. Circular, Frederick County TransIT, and Montgomery County's RideOn have deployed electric busses. Through a partnership with Dominion, Virginia localities, including Arlington, Alexandria, Fairfax County and Prince William County are deploying electric school buses as part of a plan to move Virginia towards all-electric school bus fleets by 2030.[lix]

Supporting Overall GHG Reduction Goal

MHDVs are responsible for 25 percent of transportation emissions in the region. As the regional electricity supply continues to increasingly rely on renewable sources of generation, the emission reduction potential of EVs compared to internal combustion vehicles continues to increase. With 10 percent of total GHG emissions in the region generated by MHDVs, local policies and programs to accelerate the adoption of electric MHDVs have the potential to significantly reduce emissions.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, approximately 7 percent of medium-duty and 6 percent of heavy-duty vehicles will need to be battery electric vehicles (BEVs) or plug-in hybrid-electric vehicles (PHEVs).

How COG Can Support

- Advocate for state and national actions and incentives to fund MHDV electrification.
- Support partners with grant applications to advance electric MHDV deployment.
- Support Clean Cities, local jurisdictions, and industry partners in engaging and educating local industry on opportunities and incentives to electrify their MHDV fleets.

How Member Jurisdictions Can Support

- Transition public fleet MHDVs to electric.
- Connect local private fleets with partners and opportunities to educate and incentivize transition to electric.

Region Forward Co-Benefits:

- **Health and Human Services**: MDHV diesel vehicles are a key source of local air pollution.[lx] To reduce localized air pollution, electrification prioritization should be given to vehicles that primarily operate in underserved communities with a concentration of industries.
- **Economy and Equity**: Expanding EV charging infrastructure to support electrification of MHDVs can create high quality electrician and construction industry jobs.

ZEV-3: BUILD OUT REGIONAL ELECTRIC VEHICLE CHARGING NETWORK

Action Overview

A critical barrier to the accelerated adoption of electric vehicles (EVs) by residents and businesses in the region is a lack of adequate EV charging stations. Enabling access to EV charging, especially at home, the workplace and along key corridors for long-distance trips, is critical to reducing drivers' fear of running out of electricity before reaching a destination ('range anxiety').

Local governments have several tools available for accelerating the build out of the EV charging network, including directly installing EV charging at publicly owned facilities, mandating or incentivizing newly constructed buildings in the community to accommodate EV charging, and developing EV infrastructure plans to guide deployment. The City of Frederick adopted a Plug-In EV Infrastructure Implementation Plan to establish a roadmap for enhancing the network of EV charging infrastructure across the City to meet future demand. Arlington County and community partners have implemented combined solar and EV charger buying cooperatives.[lxi]

Supporting Overall GHG Reduction Goal

As the regional electricity supply continues to increasingly rely on renewable sources of generation, the emission reduction potential of EVs compared to internal combustion vehicles continues to increase. With 34 percent of total GHG emissions in the region generated by fossil fuel on-road vehicles, local policies and programs to accelerate the build out of the EV charging network have the potential to significantly reduce emissions.[lxii]

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, assuming 50 percent of EV drivers have access to at-home charging, the region will need an estimated 71,000 workplace level 2, 42,000 public level 2, and 7,600 DC fast chargers to support 34 percent of all light duty vehicles being EVs.

How COG Can Support

- Support jurisdictions in adopting EV-ready new construction ordinances or incentives.
- Conduct regional EV gap analysis to identify most critical gaps in EV charging network.
- Support state/national incentives for EV charging deployment and technology advancement.
- Support local EV planning initiatives.

How Member Jurisdictions Can Support

- Require new developments to install EV infrastructure or be EV-Ready.
- Provide or promote incentives for EV infrastructure deployment in the community.
- Develop EV infrastructure plans for community deployment.
- Develop EV infrastructure strategy for the public fleet and deploy EV infrastructure at public facilities, garages, and refueling facilities.
- Partner with utilities or other EV infrastructure providers to deploy in the community.
- Implement innovative pilot initiatives to advance new technologies, including vehicle-to-grid, regenerative power, and solar-powered EV infrastructure.

Region Forward Co-Benefits:

- **Equity**: Plans to build out EV charging should prioritize disadvantaged communities to ensure equitable access to charging.
- **Health and Human Services**: Use of gasoline, and particularly diesel, to power passenger vehicles is a major cause of criteria air pollutants and associated adverse health impacts. EVs, which release no tailpipe emissions, can help to significantly reduce local air pollution.

ZW-1: IMPLEMENT CURBSIDE ORGANICS RECYCLING PROGRAMS

Action Overview

Curbside organic compositing enables residents and businesses to have separated, organic waste collected with regular trash and recycling collection. This organic waste, including food scraps and yard trimmings, is then directed to dedicated organic composting sites, opposed to landfill or waste-to-energy (WTE) facilities, where it is used to produce nutrient-rich soil additives for growing foods and plants.

Prince George's County's Organic Composting Facility is the largest municipal installation of its kind on the East Coast. The County launched a food scraps curbside collection pilot from December 2017 to January 2019 with approximately 200 households from four diverse communities. An estimated total of 112,000 pounds or 56 tons of food scraps were collected and diverted from the landfill in 14 months. The program is now expanding to 3,000 households and plans county-wide deployment in the next two to three years. Alexandria, Arlington County, Washington D.C. and several additional jurisdictions provide dedicated locations for residents to drop off food scraps.[lxiii]

Supporting Overall GHG Reduction Goal

Organic material that decomposes under anaerobic (without oxygen) conditions present in a landfill causes large amounts of methane (CH_4) – a GHG 25 times more power than carbon dioxide (CO_2) – to be released into the atmosphere. However, under the aerobic (with oxygen) conditions present at a compositing facility, the breakdown of organic material does not produce methane because methane-producing microbes are not active in the presence of oxygen.[lxiv] More than 2 percent of total GHG emissions in the region are associated with solid waste disposal to landfills and WTE facilities and curbside organic recycling programs has the potential to reduce emissions in the waste sector.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, curbside compositing will need to be expanded significantly to support the region in diverting 80 percent of all materials (including composting and recycling) from landfills and WTE facilities.

How COG Can Support

- Aggregate regional demand for curbside organic recycling collection to bring down costs associated with contracted waste haulers and development/expansion of composting facilities.
- Facilitate regionally shared composting projects.

How Member Jurisdictions Can Support

- Implement compositing programs.
- Invest in composting infrastructure.
- Install compost collection bins/sites outside multi-unit dwellings and public facilities.

Region Forward Co-Benefits:

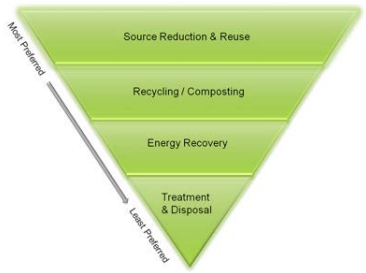
- **Land Use:** Diverting organics from landfills decreases the amount of overall waste sent to landfills and, as a result, the amount of open space occupied by landfills.
- **Economy and Equity:** Expanding curbside compositing programs and the development of compositing facilities will create jobs across the region in the waste hauling and construction industries. To ensure equitable access to curbside composting, disadvantaged communities should be prioritized for pilot initiatives and program expansion.

ZW-2: REDUCE SOLID WASTE GENERATION

Action Overview

Reducing solid waste generation prevents waste from being sent to landfill or waste-to-energy (WTE) facilities. Reducing waste at the source is the most preferred waste management strategy (Figure 9). This can be done through behavior change or by reusing items, reducing packaging, redesigning wasteful products, and buying in bulk. Recycling is another strategy for reducing solid waste, where products are recycled into raw materials and then remanufactured into new products. [lxv]

Figure 9: Waste Management Hierarchy



The Prince William County Eco-Park, including the landfill and compost facility, is an example of transforming waste into a resource that produces energy, recovers and recycles, and provides opportunities for education. Annually, more than 52,000 tons of waste is diverted from the landfill for recycling, while an additional 40,000 tons of yard waste is composted. In addition, the Eco-Park will soon have a solar energy generating facility on-site as well as food composting.[lxvi]

Supporting Overall GHG Reduction Goal

Reducing solid waste generation reduces the amount of waste that is sent to landfill or WTE facilities, thereby reducing solid waste GHG emissions. WTE facilities burn garbage and typically generate electricity from the combustion of solid waste, which also produces GHG emissions. More than 2 percent of total GHG emissions in the region are associated with solid waste disposal to landfills and WTE facilities. Minimizing waste generation reduces emissions, while contributing to a cleaner, healthier region.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, local residents and businesses addressing their consumption and disposal patterns will be critical to support the region in diverting 80 percent of all materials from landfills and WTE facilities. Additionally, by 2030, single-use plastics will need to be banned in the majority of jurisdictions to support the 80 percent diversion target.

How COG Can Support

- Support coordination on more direct measures at reducing waste above and beyond the more common approach of plastic and paper bag fees.
- Continue Go Recycle Campaign and incorporate education to consumers on problems associated with single-use packaging.

How Member Jurisdictions Can Support

- Implement single-use plastic and polystyrene bans.
- Invest in waste collection systems and infrastructure, including recycling facilities, and improve waste collection services in underserved communities.

Region Forward Co-Benefits:

- **Land Use:** Reducing the amount of waste sent to landfills decreases the amount of open space occupied by landfills.
- **Economy and Equity:** Investments in waste collection systems and infrastructure has the potential to create local jobs in the waste and construction industries.
- **Equity:** Focusing on expanding and improving on waste collection services offered to historically underserved communities can help improve the communities' overall quality of life.

ZW-3: BUILD MARKETS FOR CIRCULARITY

Action Overview

Building markets for circularity encompasses principles that eliminate waste and pollution, while fostering economic productivity through the reuse of materials set aside as waste. The more traditional linear economy is where resources are taken, made into products, and discarded when no longer needed. Circular economy markets can reduce waste, while also creating jobs and supporting economic prosperity.[lxvii]

Fairfax, Arlington, Loudoun, and Prince William Counties and the City of Alexandria have partnered together to recover and recycle glass waste in Northern Virginia. There are currently 36 purple glass-only drop-off containers located across these jurisdictions that serve to collect glass waste, which is then brought to Fairfax County's "Big Blue" processing plant. The plant crushes glass bottles and jars into sand and gravel, which can then be used for paving, construction, and landscaping, as well as stormwater control applications. Some glass is also sent out of state to be turned into bottle glass and other projects.[lxviii]

Supporting Overall GHG Reduction Goal

Building markets for circularity reduces the amount of waste that is sent to landfill or waste-to-energy (WTE) facilities, thereby reducing solid waste GHG emissions. WTE facilities burn garbage and typically generate electricity from the combustion of solid waste, which also produces GHG emissions. More than 2 percent of total GHG emissions in the region are associated with solid waste disposal to landfills and WTE facilities.

Level of Implementation Needed to Reach Overall GHG Goal:

By 2030, local residents and businesses addressing their consumption patterns and maximize reuse of materials will be critical to support the region in diverting 80 percent of all materials from landfills and WTE facilities.

How COG Can Support

- Identify potential to build markets for circular economy products and services, as well as recovered materials in public works projects.
- Continue Go Recycle Campaign and incorporate education to consumers on circular economy.

How Member Jurisdictions Can Support

- Implement strategies and good practices for circular consumption.
- Incentivize exchange programs and markets for second-hand products.
- Promote repair and restoration services.
- Set up programs for training and employment in the circular economy.

Region Forward Co-Benefits:

- **Land Use:** Promoting circular consumption, exchange programs, and markets for second-hand products reduces the amount of waste sent to landfills and decreases the amount of open space occupied by landfills.
- **Economy and Equity**: Businesses and programs that make use of recovered materials have the potential to reduce emissions, with the added benefit of increasing economic productivity.
- **Education:** Establishing programs for training in the circular economy will provide significant educational value to the community.

SQ-1: STRATEGICALLY PLANT NEW TREES ON PUBLICLY OWNED LAND

Action Overview

Carbon sequestration is the process by which atmospheric CO_2 is absorbed by trees and other vegetation through photosynthesis and stored as carbon in biomass, including trunks and roots. Because trees and vegetation absorb CO_2, they are known as 'carbon sinks' – reservoirs that absorb more carbon than they release. Carbon sinks help to offset other sources of GHG emissions, including those derived from the combustion of fossil fuels.[lxix]

The most direct way that member jurisdictions can increase levels of carbon sequestration in their communities is by taking action to expand tree canopies on publicly owned lands – including parks, buildings and facilities. Developing a tree inventory can serve as a critical, first step for jurisdictions to assess the baseline tree canopy cover and prioritize publicly owned properties that could accommodate and benefit from additional tree canopy. Over three quarters of COG member jurisdictions have completed a tree canopy assessment and have established a tree canopy cover goal. Leveraging nonprofit partners and community volunteers to play a key role in the inventorying, planting, and stewardship of trees on public lands will be key to achieving these canopy cover goals. For example, "ReLeaf" partners, including Arlington and Fairfax ReLeaf, have been instrumental in organizing volunteers to plant thousands of trees along public highways and public lands.[lxx]

Supporting Overall GHG Reduction Goal

Expanding the tree canopy on publicly owned lands can help offset emissions from difficult-to-eliminate fossil fuels, including those combusted to heat buildings. As regional emissions continue to decrease, and difficult-to-eliminate emissions make up a larger share of total emissions, having the ability to offset emissions through sequestration will be critical.

Level of Implementation Needed to Reach Overall GHG Goal:

Planting trees on land owned by jurisdictions will be critical to supporting the overall target of increasing regional tree canopy cover 2.4 percent above 2012 levels by 2030.

How COG Can Support

- Host trainings and workshops among regional volunteer groups to share best practices.

How Member Jurisdictions Can Support

- Inventory trees on publicly owned land.
- Identify areas on publicly owned lands appropriate and available for additional planting.
- Provide base funding to support volunteer tree stewardship of existing and newly planted trees on publicly owned lands.
- Maintain or improve community initiatives supporting tree management or planting.

Region Forward Co-Benefits:

- **Environment:** Tree preservation improves air and water quality.[lxxi]
- **Land Use:** Tree preservation is directly linked to preservation of open space, green space, and wildlife habitat.
- **Health and Human Services and Equity:** Tree preservation reduces health risks by improving air quality, improving water quality, and reducing urban heat island effects. Tree planting should be prioritized in disadvantaged communities with limited access to parks and green spaces.[lxxii]

SQ-2: ENHANCE REGULATORY CAPACITY TO MANAGE TREE CANOPY AND FOREST PROTECTION

Action Overview

Ensuring that member jurisdictions programs are structured in such a way to provide tree canopy and forest protection initiatives with adequate regulatory capacity is critical to achieving the region's carbon sequestration goals. Establishing tree canopy cover goals and a tree canopy management policy, allocating adequate staff time and budget, and consistent monitoring are needed to reach these goals. One method for ensuring that member jurisdictions are on the right path for developing regulatory capacity is through participation in the Tree City USA designation process.[lxxiii]

The majority of COG member jurisdictions have established tree canopy goals and earned the Tree City USA designation. Several member jurisdictions have also taken additional key steps to adequately fund tree canopy initiatives. For example, to ensure adequate funding is available for monitoring, inspection, and enforcement of tree canopy regulations, Falls Church's Zoning Ordinance requires owners to deposit a cash bond in an escrow account prior to the issue of building or development permits. Additionally, the City of Frederick recently launched the Tree Frederick Program, a 50-50 cost share program to help residents cover the costs of planting trees and make progress towards the city's 40 percent tree canopy cover goal.[lxxiv]

Supporting Overall GHG Reduction Goal

Increasing regulatory capacity to manage tree canopy programs can help offset emissions from difficult-to-eliminate fossil fuels, including those combusted to heat buildings. As regional emissions continue to decrease, and difficult-to-eliminate emissions make up a larger share of total emissions, having the ability to offset emissions through sequestration will be critical.

Level of Implementation Needed to Reach Overall GHG Goal:

Ensuring sufficient regulatory capacity for tree canopy and forest protection initiatives will be critical to supporting the overall target of increasing regional tree canopy cover 2.4 percent above 2012 levels by 2030.

How COG Can Support

- Provide technical assistance resources to assist common tree canopy program management issues among COG members.

How Member Jurisdictions Can Support

- Adopt a tree canopy/forest cover goal.
- Earn and maintain Tree City USA designation.
- Define a tree canopy management policy in local regulations.
- Dedicate budget and staff time to manage tree planting and preservation initiatives.
- Define annual progress monitoring and reporting requirements.

Region Forward Co-Benefits:

- **Environment:** Tree preservation improves air and water quality.[lxxv]
- **Land Use:** Tree preservation is directly linked to preservation of open space, green space, and wildlife habitat.
- **Health and Human Services and Equity:** Tree preservation reduces health risks by improving air quality, improving water quality, and reducing urban heat island effects. Tree planting should be prioritized in disadvantaged communities with limited access to parks and green spaces.[lxxvi]

SQ-3: ENHANCE TREE PLANTING AND PRESERVATION ON PRIVATELY OWNED LANDS

Action Overview

One of the most effective strategies for expanding tree canopy coverage in the region is through the provision of incentives and funding mechanisms that encourage landowners to protect their trees. Options available to member jurisdictions include mitigation banking, adopt-a-tree programs, memorial trees programs, and incentives for planting trees to achieve specific environmental or ecological goals.[lxxvii]

During the construction and development process, many jurisdictions require the replacement of trees that have been damaged or removed. In cases where this is not possible, tree banking enables developers or landowners pay into a dedicated tree planting fund which then uses the funds to plant trees in an alternative location. In Prince George's County, for example, developers or landowners are required to purchase credits from a woodland conservation bank if requirements cannot be met on-site. These woodland conservation banks are land that has been intentionally preserved as perpetual woodlands to satisfy the conservation requirements of other properties in the county.[lxxviii]

Supporting Overall GHG Reduction Goal

Increasing tree canopy through incentives and funding can help offset emissions from difficult-to-eliminate fossil fuels, including those combusted to heat buildings. As regional emissions continue to decrease, and difficult-to-eliminate emissions make up a larger share of total emissions, having the ability to offset emissions through sequestration will be critical.

Level of Implementation Needed to Reach Overall GHG Goal:

Providing incentives and funding mechanisms to support tree planting and preservation will be critical to supporting the overall target of increasing regional tree canopy cover 2.4 percent above 2012 levels by 2030.

How COG Can Support

- Develop a Regional Urban Forest Action Plan.
- Develop fundraising guidebook and resources for interested COG members.
- Support COG members in identifying priority co-benefit areas with tree planting and preservation.
- Support COG members' in calculating and establishing canopy goals for major land use categories.

How Member Jurisdictions Can Support

- Calculate and establish tree canopy goals for major land use categories.
- Establish local tree planting and preservation incentives, funding mechanisms and policies.
- Establish on-site and off-site metrics for tree preservation such as tree mitigation banks or funds.
- Create or enhance adopt-a-tree and memorial tree programs to expand funding sources.

Region Forward Co-Benefits:

- **Environment:** Tree preservation improves air and water quality.[lxxix]
- **Land Use:** Tree preservation is directly linked to preservation of open space, green space, and wildlife habitat.
- **Housing:** Providing alternatives to on-site tree preservation compliance enables denser housing development near transit/activity centers while still preserving trees.
- **Health and Human Services and Equity:** Tree preservation reduces health risks by improving air quality, improving water quality, and reducing urban heat island effects. Tree planting should be prioritized in disadvantaged communities with limited access to parks and green spaces.[lxxx]

Transportation and Land Use

[To be inserted]

Commented [MD8]: This section is intended to be a description of how COG transportation and land use work supports climate mitigation goals. It can include descriptions of Visualize 2045 (transportation plan) and Activity Centers. So rather then repeat those actions here in this plan, we would reference those actions. This is up for discussion.

CLIMATE RISKS AND VULNERABILITIES

Assessment Overview

In 2018, The Intergovernmental Panel on Climate Change (IPCC) released the *Global Warming of 1.5°C*, an IPCC special report, highlighting that the world is already experiencing the impacts of 1°C warming above pre-industrial levels but more severe climate impacts could be avoided if global warming is limited to 1.5 degrees Celsius. If the rate of warming continues, 1.5°C warming is likely to occur between 2030 and 2052 with more frequent and severe extreme weather events becoming even more prevalent.[lxxxi]

As the IPCC noted internationally, metropolitan Washington is also experiencing the impacts of a changing climate. Observations in metropolitan Washington show that temperatures and the water surface level in the Potomac River have been rising and will continue to rise. Extreme weather events and increases in the number of extreme heat and cold days will increase risks to health, energy usage patterns, plant and animal habitats, and infrastructure. These changes are also affecting stormwater, drinking water, and wastewater. Implementing regional adaptation strategies are necessary in order to reduce the impacts of climate change.[lxxxii]

A climate risk and vulnerability assessment (CRVA) was conducted for metropolitan Washington with the goal of understanding the climate hazards that face region and assessing the likelihood and impact of current and future hazards on the region. Climate change may increase the frequency or severity of climate hazards in metropolitan Washington, including extreme heat (high day and night temperatures), drought, flooding (flash, riverine, and coastal), lightning and thunderstorms, and extreme winter conditions.

METHODOLOGY

The regional CRVA methodology is based on the Global Covenant of Mayors for Climate and Energy (GCoM) framework. GCOM is a global alliance of cities and local governments that support voluntary action to address climate change and ensure a low emission, climate resilient future.[lxxxiii] The CRVA identifies and describes current and anticipated climate hazards the metropolitan Washington faces. As shown in Table 3**,** each hazard is assigned a risk level, based on probability and level of consequence (probability x consequence). After the hazard risks are identified, an assessment is conducted to determine the future change in intensity and frequency, and the timeframe over which this will occur: Immediately, Short Term (by 2025), Medium Term (by 2050), and Long Term (After 2050).

Table 3: Climate Risk Sourcing Matrix

		Probability		
Consequence		Low (1)	Moderate (2)	High (3)
	High (3)	3	6	9
	Moderate (2)	2	4	6
	Low (1)	1	2	3

Next, vulnerabilities were assessed to determine the degree in which the people, systems, sectors, and systems are susceptible to current and future climate impacts. The impacts assessed include but is not limited to: services lost, environmental impact, property damages, public health threats, economic loses, and other disruptions to day-to-day operations. For each hazard, relevant population groups in the region were identified that are most vulnerable to future climate hazards and impacts. Finally, for each hazard, factors were assessed that may impact the region's adaptive capability.

To conduct the CRVA relevant climate studies and reports were leveraged followed by stakeholder engagement in climate planning work sessions. Both the research and stakeholder engagement informed the final CRVA results to determine the adaptive capability of the region. The findings of the CRVA provides guidance to the priority collaborative resilience actions identified in this Plan.

SUMMARY RESULTS

As shown in Table 4, the most prominent climate hazards facing metropolitan Washington include extreme heat and flash and riverine flooding. More frequent extreme heat days will lead to public health concerns, increase energy demand, travel disruptions, and maintenance and infrastructure damages. With more frequent and intense storms, flash and riverine flooding will increase disruptions and damages to infrastructure and emergency services, and further threaten vulnerable populations.

Table 4: Risk Level of Hazards in Metropolitan Washington

Hazard	Probability	Consequence	Risk
Extreme Heat	3	3	9
Drought	2	3	6
Flooding (Flash and Riverine)	3	3	9
Coastal Flooding	3	2	6
Lightning/Thunderstorm	3	2	6
Extreme Winter Conditions	2	3	6

The region must adapt to climate change. Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences."[lxxxiv] Table 5 shows the degree of challenge identified for each sector evaluated in the CRVA. Infrastructure conditions pose the highest degree of challenge due to the impacts on maintenance costs, aging facilities, interoperability, and increased demand. Resilient critical infrastructure is essential to the well-being, health, and safety of the people in metropolitan Washington. Implementing resilient measures for all critical infrastructure by 2050 is necessary in order to respond to a changing climate.

Table 5: Metropolitan Washington Adaptive Capacity Degree of Challenge

Factor	Degree of Challenge
Infrastructure Conditions/Maintenance	High
Access to Basic Services	Moderate
Access to Healthcare	Moderate
Public Health	Moderate
Housing	Moderate
Poverty	Moderate
Community Engagement	Moderate
Environmental Conditions	Moderate
Economic Health	Low

VULNERABLE POPULATIONS

Climate change will impact people and communities differently. Potentially vulnerable populations may include low-income, minority, marginalized groups, women and girls, persons in sub-standard housing, people with limited English proficiency, the elderly, children, people with chronic health problems, or disabled persons. Where possible, the regional CRVA overlays the Equity Emphasis Areas (EEAs) developed originally for transportation planning and evaluation of communities with more health challenges with climate risks as a starting point to identify potentially vulnerable populations. Metropolitan Washington EEAs, identified by COG and its members, include communities that have a higher than average concentration of low-income, minority populations, or both. As vulnerable populations face greater risks, their consideration and inclusion in climate change planning is essential to ensure equitable distribution of benefits. Creating resilient communities is only possible when inclusion of vulnerable populations needs is met.[lxxxv]

Climate Hazards, Risks and Impacts

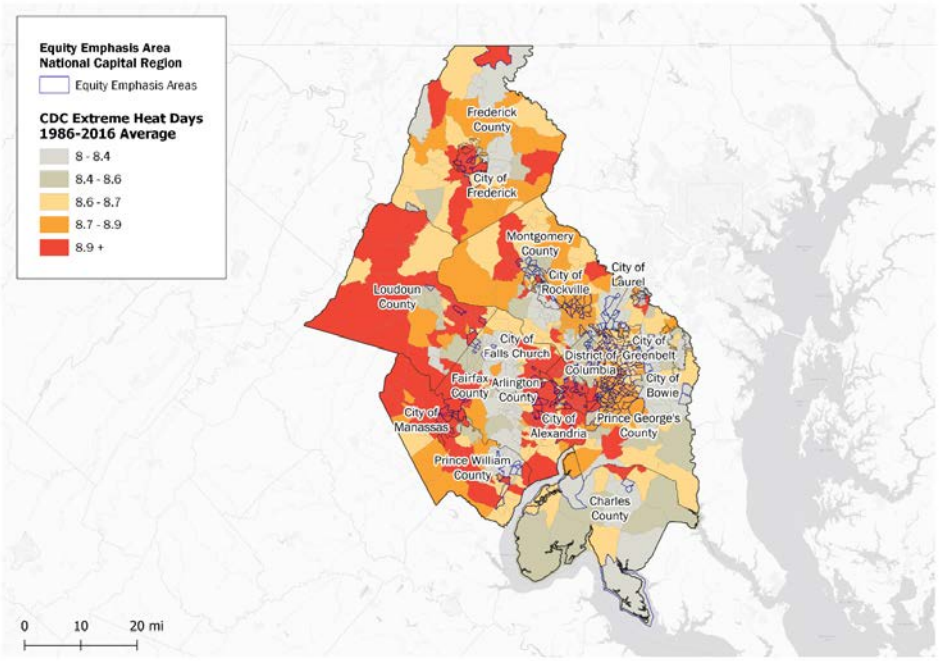
EXTREME HEAT

Probability	Consequence	Risk
3	3	9

Extreme heat occurs when temperatures that occur in the summertime are significantly higher or more humid than the average temperature the area typically experiences. Extreme heat has a high probability of occurring in metropolitan Washington and poses a high threat to human life. [lxxxvi]

Heat is the number one cause of weather-related injuries and fatalities in the region. In 2019, 53 days at or above 90°F and 13 days at or above 95°F were recorded at Dulles International Airport. Across the region, Figure 10 shows the average number of extreme heat days from 1986- 2016 overlaid with EEA's in the region. EEAs are more heavily burdened by extreme heat. The median number of extreme heat days a year in the region is 8.61 days, the median in EEAs is 8.75 days. Potentially vulnerable populations may face barriers such as access to air conditioning, housing, and cooling centers. Populations that rely on electronic medical devices and refrigerated medication face a greater risk during power outages from extreme heat days. Populations that reside in urban areas, are more at risk due to urban heat island effects. [lxxxvii]

Figure 10: Extreme Heat Days and Equity Emphasis Areas

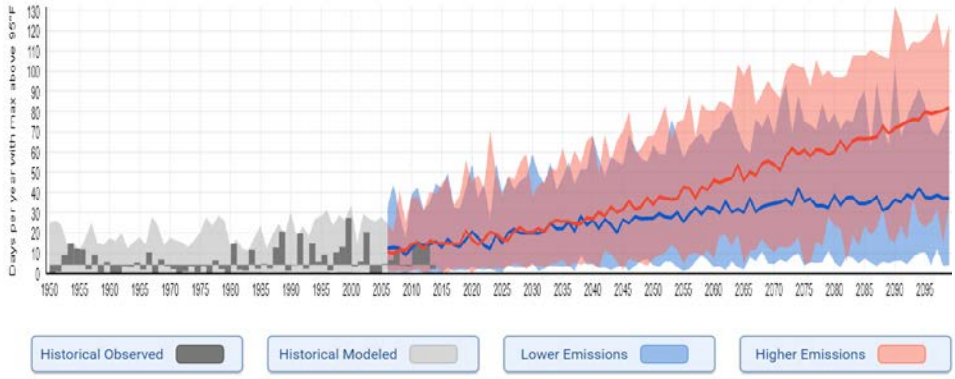


Source: Centers for Disease Control and Prevention (CDC) National Environmental Public Health Tracking Network Analysis Data Explorer and COG Equity Emphasis Areas

The number of extreme heat days will increase by 2025, with extreme both heat days and heat waves occurring more frequently. As seen in Figure 11, the National Oceanic and Atmospheric Administration (NOAA) Climate Explorer shows the number of days per year with temperatures greater than 95°F from 1950 to 2095, the red and blue fill indicates the range of future projected temperatures under high and low emissions scenarios, respectively. The data indicates a significant increase in the projected number of heat days; that the number of days per year with temperatures above 95°F may reach more than 50 to 100 days by 2065 under the high emissions scenario. [lxxxviii]

Similarly, the Climate Ready DC Plan projects that the District of Columbia would experience 40 to 75 days with temperatures above 95°F by 2080 under a high emission scenario.[lxxxix]

Figure 11: Number of Projected Days Over 95°F from 1950 until 2095



Source: NOAA Climate Explorer

Extreme heat presents challenges to infrastructure. Extreme heat can lead to more frequent travel disruptions, increased road surface damage and pavement softening, increase in rail infrastructure deterioration from buckling and expansion, impact aviation runways and plane takeoff, and impact electrical infrastructure (i.e. sagging lines). An increase in the number of extreme heat days may accelerate deterioration of other assets such as buildings, bridges, and vegetation, and increase cost of maintenance. Higher temperatures will result in increased cooling costs and energy demands and disruptions and damages to utility infrastructure.

Increased days of extreme heat can also lead to higher ozone pollution levels and could make it more difficult for the region to attain or maintain attainment with National Ambient Air Quality Standards (NAAQS) for ozone. High heat, unhealthy air days can trigger heat stroke, respiratory problems, heat exhaustion, hyperthermia, and death. The elderly, small children, persons with chronic diseases, persons with allergies, low-income populations, and outdoor workers are especially vulnerable to heat-related illnesses. An increase and prolonged number of extreme heat days will increase the transmission of diseases, making a longer tick and mosquito season common and increase the likelihood of vector-borne diseases. By the 2060s, the season could begin three weeks earlier in Virginia than it did from 1992 to 2007.[xc]

DROUGHT

Probability	Consequence	Risk
3	2	6

Drought is affected by the number of precipitation-free days and warmer temperatures, causing greater evaporation and evapotranspiration. Drought can cause dry weather patterns, low water supply, and can affect agricultural crops. While upstream reservoirs provide some protection from drought for metropolitan Washington, the region is particularly at risk due to the heavy reliance on the Potomac River as the primary source of potable water. Some jurisdictions are 100 percent reliant on water withdrawals from the Potomac River. Conditions in the Potomac River Basin frequently differ between the upper and lower portions of the Basin. Drought has a moderate probability of occurring but has a high consequence of impact in the region on the water supply and agricultural systems.[xci]

Although droughts account for a small percentage of hazards in the region, impacts can be severe. In September 2010, due to unusually dry conditions, COG's Drought Coordination Committee (DCC) declared a drought 'WATCH"; The WATCH ended when Tropical Storm Nicole hit the region. Since 2000, several smaller community water systems have briefly declared WARNING or EMERGENCY stages due to limited rainfall and less resilient water supply systems. In October 2019, The October 1, 2019 U.S. Drought Monitor for the Potomac Watershed indicated that abnormal dryness (D0) and moderate drought (D1) exist throughout the region due to an unusually hot and dry September.[xcii]

By 2050, droughts may occur more frequently and be prolonged, with an increased intensity. As most of the region's drinking water comes from the free-flowing Potomac River, more frequent and intense droughts may increase the demand of water, lower base flows in the Potomac River watershed, and degrade water quality. The food and agriculture sector may face reduced crop yield and crop losses. Vulnerable populations are at a high risk, due to the indirect impacts of the disruptions of agriculture and water systems.[xciii]

FLASH AND RIVERINE FLOODING

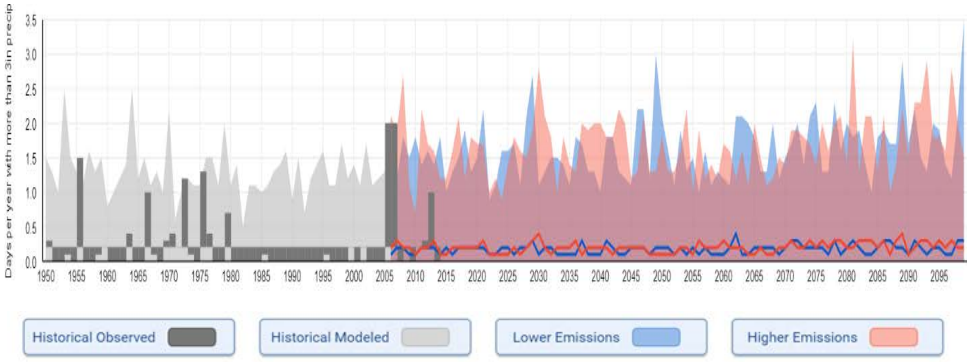
Probability	Consequence	Risk
3	3	9

Flash flooding occurs when the ground exceeds the ability to absorb heavy or excessive rainfall. Riverine flooding occurs when excessive rainfall causes high flow rates and water levels to rise over the top of riverbanks. This may occur due to thunderstorms, combined rainfall and snowmelt, ice jam, or heavy rain from tropical storms. Flash and riverine flooding have a high probability and high consequence of impact, posing a high risk to public health, transportation, water supply and sanitation, and properties. Coastal storm surge has a lower probability and medium consequence in metropolitan Washington.[xciv]

The region has experienced many flash and riverine flooding events. In 2006, Washington D.C., experienced several days of intense rainfall, equivalent to a 200-year storm. The precipitation overwhelmed the storm sewer system. Several Federal agencies, Smithsonian museums including the National Gallery, and the Washington Metropolitan Area Transportation Authority (WMATA) had severe impacts to their operations, buildings, and infrastructure. In addition to damages to infrastructure and businesses, the event caused disruptions to critical services. A couple other notable examples of flash and riverine include May 2018 flash flooding in Frederick and July 2019 flash flooding in Northern Virginia. [xcv]

The frequency and intensity of heavy precipitation events are likely to increase. Figure 12**,** shows precipitation projections will occur at a higher range than historical records, demonstrating the possibility of more frequent heavy precipitation events. A 100-year precipitation event could become a one in 25-year event by mid-century, and a one in 15-year event by the 2080's.[xcvi]

Figure 12: Projected Number of Days per Year with Over 3 Inches of Precipitation

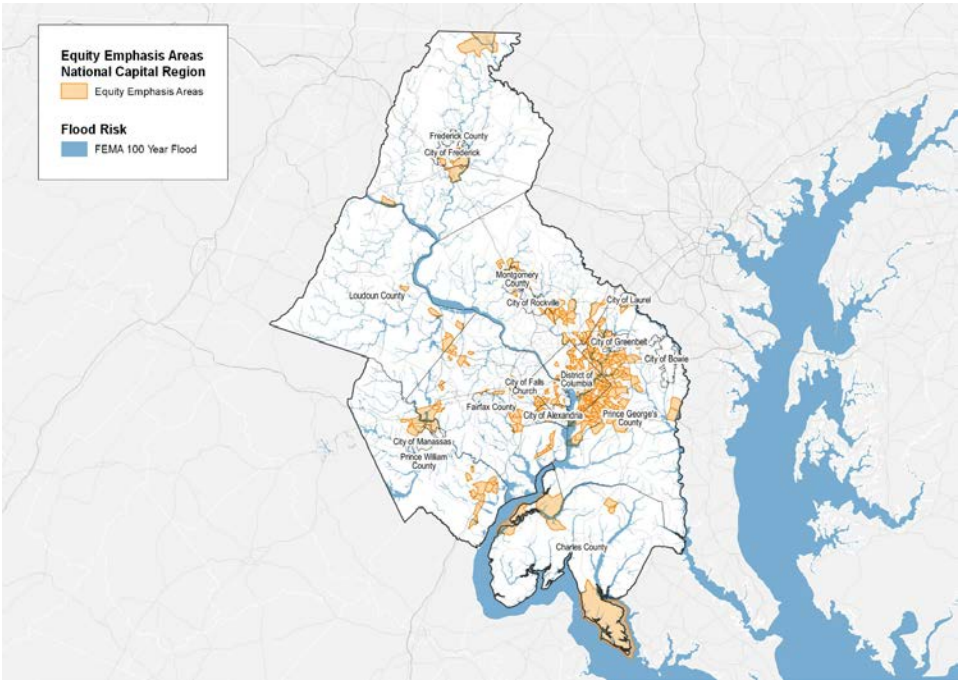


Source: NOAA Climate Explorer

An increase in the number and intensity of flash and riverine flooding may cause disruptions to the transportation and energy sector including flooding roadways, physical damages, loss and disruption to critical and emergency services, and wide-scale power outages. Sewer systems may be damaged due to the overwhelming level of water and pollution from storm water runoff may increase a degradation of water quality and shoreline loss.

Individuals with lower socioeconomic status, such as low-income households, persons in sub-standard housing, and unemployed persons are more likely to have limited resources that may hinder their ability to prepare for flooding and evacuate before and during an event. Persons with disabilities, the elderly, persons with chronic conditions, and language barriers are also at risk during flood events. Persons residing in flood zones are at risk for loss of property and injuries. As seen in Figure 13, Federal Emergency Management Agency's (FEMA) 100-year floodplains run through more than 60 percent of Equity Emphasis Areas (EEAs), where currently approximately 1 million people reside. Also notable, is that more than half of the region's EEAs are within the Anacostia watershed (mainly in the District of Columbia and western border of Prince George's County). These areas can serve as a starting point for local jurisdiction to work with these communities to further identify potentially vulnerable populations, how they will be impacted by riverine flooding, and how to address their needs.[xcvii]

Figure 13: Equity Emphasis Areas and FEMA's 100-Year Floodplains



Source: FEMA and COG Equity Emphasis Areas

COASTAL FLOODING

Probability	Consequence	Risk
3	2	6

Coastal flooding can occur in the form of nuisance or tidal flooding during extreme high tides and during coastal storms that produce intense rain, storm surges and high waves. Coastal flooding poses a risk to human health including injuries, death, and illnesses associated with contaminated water including diarrhea and stomach illnesses.[xcviii] Coastal flooding poses risks to transportation services, infrastructure, residential housing, businesses, and the economy.

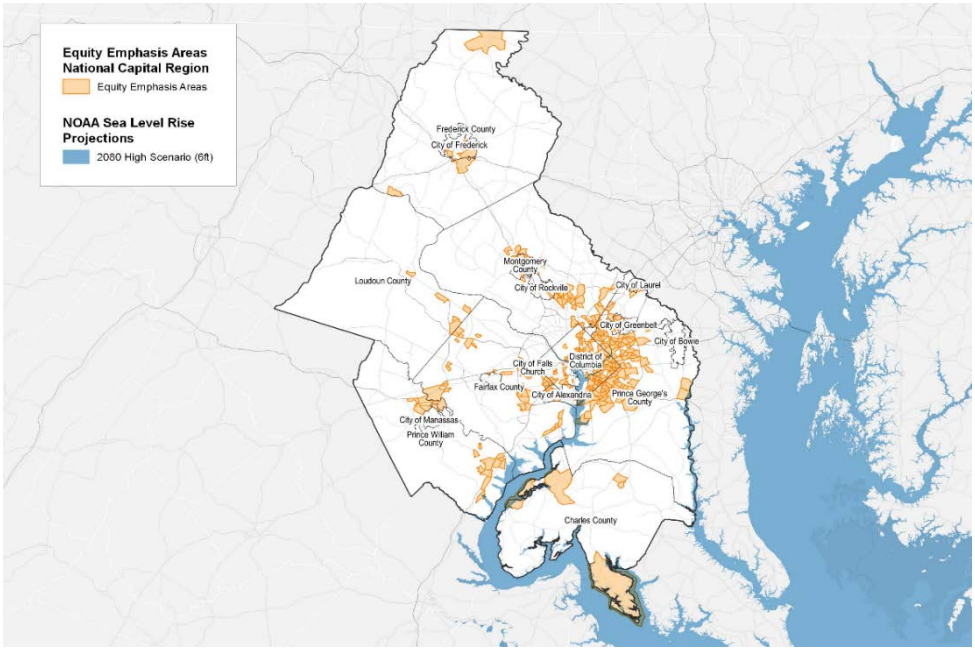
In the past 90 years, the Potomac and Anacostia River, both tidal rivers have experienced 11 inches of sea level rise. Nuisance flooding has increased over 300 percent along the riverfront. Effects of sea level rise are observable, including shoreline erosion and deterioration of tidal wetlands. Recent examples of coastal flood events include impacts of Hurricane Isaac (2003), the 2006 Mid-Atlantic Storm and Tropical Storm Lee (2011). [xcix]

The region may experience more intense and more frequent coastal flooding impacts. The District of Columbia could experience 2 to 6 feet of additional sea level rise towards the end of the century. Increases in sea level rise will cause tidal and nuisance floods with more severe impacts and a reduction of time in between floods. Storm surge floods will be more threatening in the long term with added sea level rise.[c]

Coastal areas in metropolitan Washington contain a critical convergence of infrastructure (water, energy, and communication utilities, transportation hubs, facilities and buildings) that the region's local governments, businesses, institutions, and communities depend upon. The region is also home to many federal buildings, military installations, national security facilities, and significant national monuments and cultural treasures. As sea level rises, the coastline may change and critical infrastructure that was previously not at risk may face a greater risk of flooding from storm surges. More frequent and intense coastal flooding may impact these infrastructure and facilities potentially causing damage, disruptions, and economic losses.

Coastal flooding puts vulnerable populations that live and work near the coast at a higher risk. Populations with socioeconomic barriers, including low-income households, the elderly, persons in sub-standard housing, and individuals with language barriers face greater challenges to prepare and respond to flood events. Figure 14 demonstrates the number of EEAs that fall within NOAA's high sea level rise projections (6ft). More than 10 percent of EEAs will be affected by a 6-foot sea level rise. More than 100,000 people currently live in these EEAs. These areas can serve as a starting point for local jurisdictions to work with these communities to further identify potentially vulnerable populations, how they will be impacted by coastal flooding, and how to address their needs.[ci]

Figure 14: Equity Emphasis Areas and NOAA Sea Level Rise Projections High Scenario (2080 6ft)



Source: NOAA and COG Equity Emphasis Areas

SEVERE THUNDERSTORMS/LIGHTNING

Probability	Consequence	Risk
3	2	6

A thunderstorm is a combination of precipitation, thunder, and lightning. A severe thunderstorm may additionally include hail, wind gusts of 50 knots or more or may even form into a tornado. Severe thunderstorms may also cause flooding. Severe thunderstorms and lightning have a high probability of occurring with a moderate level of impact.

The June 2012 Derecho that hit the region was a violent thunderstorm with winds recorded at upwards of 85 mph. The storm demonstrated the consequences of climate impacts on infrastructure failures. Millions of people experienced power outages for several days during a heatwave. The Washington Suburban Sanitary Commission (WSSC) experienced power loss at Potomac and Patuxent filtration plants and at more than 50 of its facilities. Transportation routes were blocked due to downed trees and power lines. The Derecho event resulted in communication infrastructure damages and 9-1-1 outages affected more than 1.5 million people in Northern Virginia and 68,000 people in the District of Columbia.[cii]

In October 2012, the region experienced sustained winds and heavy rain during Superstorm Sandy. Impacts were lessened due the region not being directly hit, pre-landfall preparedness, and coordination during response and recovery operations. During Sandy, the region experienced flooding, power outages, downed power lines and trees. The Potomac and Patuxent Water Filtration Plants maintained full power; however, other water utilities experienced short power outages, flooding, or sewer overflows. Washington Metropolitan Area Transit Authority (WMATA) suspended Metrorail and bus services for two days.[ciii]

With rising temperatures, severe thunderstorms and lightning have a high probability to occur more frequently by 2025. Future projections show the frequency and intensity of extreme precipitation events are projected to increase from 10 days per year with 1 inch of rain in a 24-hour period, to 11 days in the 2020s and 12 days by 2050. The number of days per year with more than 2 inches of rainfall per 24-hour period is expected to increase from 1 day to 3 days by the 2020s and 3.5 days by the 2050s.[civ]

More frequent and intense severe storms will cause additional impacts to energy, transportation, water, and communication services and assets. Power outages and transportation disruptions will occur due to extreme rainfall events and downed trees. Severe thunderstorms and lightning pose a public health challenge, as power outages can disrupt medical services and emergency response. More intense rainfall can damage and overwhelm water infrastructure. More frequent lightning will increase fire risk. Additionally, an increasing electric fleet may be impacted by power outages.

Long-term power outages particularly pose challenges to potentially vulnerable populations including the elderly, persons with chronic conditions, persons who rely on electric medical equipment, homeless, and those reliant on refrigerated medication. Prolonged power outages pose public health challenges and can become life threatening during heat waves and extreme cold events.

EXTREME WINTER CONDITIONS

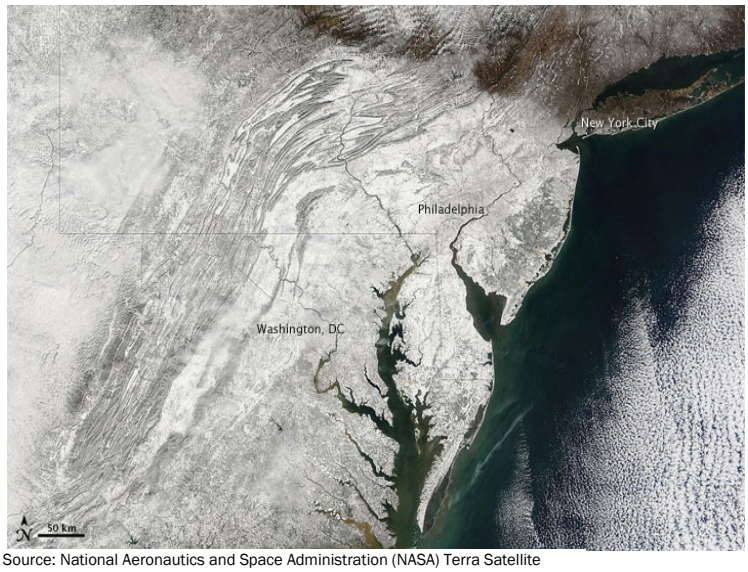
Probability	Consequence	Risk
2	3	6

Extreme winter conditions are a combination of heavy snow, blowing snow or dangerous wind chills. Extreme winter storms can create blizzards which causes low visibility due to blowing snow and wind. Ice storms occur when at least

0.25 inches of ice accumulates on an exposed surface.[cv] The region may see increases risk of ice storms as winter temperatures rise and more storms will occur near 32°F in temperature. Extreme winter conditions have a moderate probability and a high consequence, as these events pose a life-threatening risk to human health and life.

The region has experienced extreme winter conditions resulting in loss of life, significant economic impacts, and infrastructure damages. Recent winter storms events affecting metropolitan Washington include: Snowzilla (2016), Carmageddon (2011), Snowmageddon (2010), and Snowpocalypse (2009). As seen in Figure 15**,** the February 2010 severe winter storm named Snowmageddon impacted the Atlantic coastline, dropping several feet of snow in metropolitan Washington. Washington's Dulles Airport recorded 32.4 inches of snow. A State of Emergency was declared in Washington D.C, Virginia, and Maryland. Widespread power outages occurred with hundreds of thousands without power. The Federal government and schools in the region were closed for several days. Infrastructure damages and disruptions to transportation routes occurred due to excessive snow on roadways, downed trees, abandoned vehicles and vehicle accidents. It took several days to clear roads and pedestrian paths after the storm.[cvi]

Figure 15: Satellite Image of Snowmageddon



Source: National Aeronautics and Space Administration (NASA) Terra Satellite

Extreme winter conditions will occur more frequently and increase in intensity by 2025. While average annual temperatures are increasing, extreme winter events and cold snaps may continue to occur. Extreme winter conditions cause impacts to both infrastructure and people. Infrastructure can experience road surface damages and closures resulting in travel disruptions and higher maintenance costs. Roadway accidents, injuries, and fatalities are likely to coincide with winter conditions. Energy infrastructure may experience transmission structure failures resulting in power outages for many customers. Extreme cold temperatures pose a public health risk especially to persons facing homelessness, low-income households, the elderly, and persons with chronic conditions who rely on daily access to services.

REGIONAL CLIMATE RESILIENCE STRATEGY

Moving Toward Resilience

The Regional Climate Resilience Strategy includes collaborative actions to support the region in achieving the climate resilience goals of becoming a Climate Ready Region by 2030 and a fully Resilient Region by 2050. In order to move the region toward becoming more resilient, the region needs to ensure that all populations are included and prioritize resilience of the region's most vulnerable populations.

CLIMATE READY BY 2030

Recognizing everything cannot be implemented at once due to the significant capital outlay required for resilience, the region first needs to be climate ready. Climate ready involves metropolitan Washington undertaking five key components:

1. Local climate risks have been assessed and climate planning is incorporated into all government plans.
2. Climate risks are being communicated across governmental offices and to the public, with a particular emphasis on empowering diverse populations.
3. Climate planning is actively being incorporated into government operations.
4. All communities are implementing actions to reduce climate risks.
5. Establish the necessary plans, networks, funding, and other actions to ensure implementation of full resilience by 2050.

CLIMATE RESILIENT BY 2050

By 2050, this Plan calls for the region to be fully climate resilient. To do so, the region must have the ability to adapt and absorb against disturbances caused by current and future, acute and chronic climate impacts and successfully maintain essential functions. This will be realized when"

1. The region is a network of resilient and socially connected people, governments, and institutions that have constructed resilient communities. (Resilient people = resilient communities).
2. Measures have been implemented across the region to mitigate against current and future climate impacts.
    - All critical infrastructure and functions are climate resilient.
    - Resilient solutions to protect public health and safety, particularly of potentially vulnerable populations, have been deployed.
3. The region is monitoring measures to address current and future climate risks and vulnerabilities.

PRIORITY COLLABORATIVE RESILIENCE ACTIONS

The climate action areas included in this Regional Climate Resilience Strategy address Planning, Equity, and Resilient Infrastructure. Within these action areas are high-level priority actions for the Climate, Energy and Environment Policy Committee (CEEPC) and its members to focus on through 2030. All actions are voluntary. Actions have a 1-page description that includes:

- An action overview with example policies, programs, or projects;
- How the action supports regional resilience goals;
- Identifies what level of implementation is needed to meet by 2030 and beyond;

- Examples of how COG and local jurisdiction efforts that can support implementation (it's not an exhaustive list); and
- How the action benefits other *Region Forward* goals.

Commented [MD9]: May need to a bit more thinking on the Region Forward co-benefits in this section.

Table 6 is a summary of the climate action areas and priority collaborative actions described in this strategy. The actions are based on the needs identified in the regional climate risk and vulnerabilities assessment described in the previous section of this Plan. While these actions focus on what CEEPC members can do together to move the region towards the climate resilience goals, other metropolitan planning bodies at COG including the Transportation Planning Board, Region Forward Coalition, Chesapeake Bay and Water Resources Policy Committee, the Anacostia Watershed Restoration Partnership, the Water Security Work Group, Critical Infrastructure Working Group, National Capital Region Homeland Security Executive Committee, and planning and housing director committees, also need to implement action that enhance climate resilience.

Table 6: Metropolitan Washington Priority Collaborative Resilience Actions

Climate Action Area	Action ID	Priority Collaborative Action
Planning	PL - 2	Support Capacity Building for Climate Resilience Planning
	PL - 3	Develop Integrated Approach to Climate Resilience Planning
	PL - 4	Update Local Regional Plans to Address Climate Risks
Equity	EQ - 3	Support Engagement of the Public on Climate Risks, with a Particular Emphasis on Potentially Vulnerable Populations
	EQ - 4	Support Equitable Secure Energy Access
Resilient Infrastructure	RI - 1	Support Establishment of Resilience Hubs
	RI - 2	Improve the Resilience of Critical Infrastructure
	RI - 3	Implement Measures to Equitably Address Urban Heat Island
	RI - 4	Enhance Green Infrastructure Networks
	RI - 5	Implement Measures to Reduce Flood Risk

PL-2: SUPPORT CAPACITY BUILDING FOR CLIMATE RESILIENCE PLANNING

Action Overview

Metropolitan Washington is home to 24 diverse local jurisdictions that have unique capabilities, availability, and resources for climate resilience planning. To ensure an equitable climate resilient future, capacity building will require greater coordination, coherence, and integration. This is especially important to address climate hazards that have impacts that are felt across the region simultaneously. Communicating and capacity building will need to be mainstreamed across local government departments to achieve a common understanding of climate risks amongst all government staff.

To improve resiliency, the region's local govenrments need to continue to collaborative with a network of external organizations to support capacity building and training on climate resilience. One example effort is how COG coordinated from 2012 – 2014 with the National Aeronautics and Space Administration (NASA), National Capital Planning Commission (NCPC), US General Services Administration (GSA), US Global Change Research Program (GCRP), and the Smithsonian Institution to bring federal, regional and local agencies in the region together to learn about climate impacts, conduct and share agency-level vulnerabilities assessments, and identify common solutions.

Supporting A Climate Ready Region

The impacts of a changing climate are already evident in the region, with an increasing number of extreme heat days, change in precipitation patterns, and an increase in the severity of storms. Continuing to capacity build, provide training, and grow resilience expertise among government staff, non-governmental organizations, academic partners and the community is crucial to reaching climate readiness by 2030. Continuing to grow and identify avenues for integrated climate trainings and capacity-building resources, will support local level resiliency planning.

Level of Implementation Needed to Address Climate Risks

COG members participating regularly in capacity building on climate risks and resilience strategies will help the region be Climate Ready by 2030. This action addresses all climate risks including extreme heat, drought, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Continue to grow capacity building through workshops and committee meetings, and coordinate with members and partners to increase opportunities for training.
- Develop and implement a pilot training series for climate planning for local government staff.

How Member Jurisdictions Can Support

- Encourage active participation in climate planning training initiatives.
- Provide training and capacity-building across governmental departments and sectors to address climate risks and resiliency planning.

Region Forward Co-Benefits:

- **Equity:** Jurisdictions with limited resources would benefit from capacity to increase regional knowledge of heightened climate impacts on vulnerable populations in the region.

PL-3: DEVELOP INTEGRATED APPROACH TO CLIMATE RESILIENCE PLANNING

Action Overview

Regional consensus on climate planning projections and climate resilience definitions, metrics and design standards will provide a common framework for resilience planning across the region. With 24 local governments located in two states and the District of Columbia, availability of funding and resources differs across the region. Many programs would benefit from sharing of climate materials that will assist in incorporating resilience in local and regional plans. Increasing regional collaboration will allow metropolitan Washington to pool resources that benefits local governments and the region to leverage expertise from a variety of climate planning sources.

To address climate risks, the coordination and sharing of activities, best practices, consistent forward-looking climate science, and technical resources to enhance local and regional capacity is essential. The region has substantial networks, notable examples collaborative work in the region include the District of Columbia's Silver Jackets, Northern Virginia Regional Commission's Resiliency Planning Work Group, and National Oceanic and Atmospheric Administration's Climate Resiliency Workgroup.

Supporting A Climate Ready Region

Reducing vulnerabilities to human life, infrastructure, ecosystems, and the economy require a collaborative response, as climate projections and impacts of extreme events cross jurisdictional boundaries. Adopting an integrated approach and consensus on climate projections, forward-looking climate science, and resilient design standards by the region will better align climate planning efforts.

Level of Implementation Needed to Address Climate Risks

Developing a regional consensus on climate projections and climate resilience definitions, metrics, and design standards is an important step towards becoming a Climate Ready Region by 2030. This action addresses all climate risks including extreme heat, drought, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Continue sharing of best practices with local governments, federal and state agencies, businesses, non-governmental organizations, and the academic community to address climate risks, planning, modeling, and standards development.
- Continue to identify avenues for shared contractual support for climate planning, feasibility, and implementation.
- Develop a regional consensus on projections on climate risks and definitions to use in planning.
- Develop regionally appropriate climate resilient design standard guidelines.

How Member Jurisdictions Can Support

- Provide expertise and sharing of best practices of resiliency planning.
- Integrate common climate projections, metrics and resilient design standards across all departments.
- Design new and rehabilitated infrastructure to meet future-looking climate conditions.

Region Forward Co-Benefits:

- **Equity:** The region is a network of diverse local governments with various levels of resources and need. Growing climate networks and encouraging information sharing will assist in creating an equitable resilient future.

PL-4: UPDATE LOCAL AND REGIONAL PLANS TO ADDRESS CLIMATE RISKS

Action Overview

Climate projections in metropolitan Washington show more frequent and severe weather events will occur, which can lead to larger disruption of critical services and increased threat to human life. To ensure the region is prepared for climate-related disasters and possesses the ability to recover quickly, climate projections, risks and actions to reduce risks to potentially vulnerable populations need to be mainstreamed into all government plans, including but not limited to emergency plans, hazard mitigation plans, comprehensive plans, transportation plans, stormwater and watershed plans, and capital improvement plans. Mainstreaming occurs when climate considerations are a part of the overall planning process rather than outliers not central to policy and investment decisions. [cvii]

In 2017, Prince George's County adopted an updated Hazard Mitigation Plan to incorporate climate planning data. Within the plan's flood-related hazard analyses, a variety of climate data was used including data from the Maryland Department of Natural Resources Coast Smart program. The Coast Smart Flood Hazard Analysis of sea level rise on the Potomac and Patuxent Rivers was used to conduct a coastal flooding analysis and to map potential sea level rise.[cviii]

Supporting A Climate Ready Region

The climate is changing, and all government departments will need to have the ability to anticipate, address, and adapt to new and changing climate risks in order to reduce impacts on people, critical services, infrastructure, and the economy. All government offices need to understand how climate risks and impacts affect their ability to do their job and continue to provide services to the community.

Level of Implementation Needed to Address Climate Risks

In order to become a Climate Ready Region by 2030, COG and its members will need to update all plans to address climate risks. This action addresses all climate risks including extreme heat, drought, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Review and update regional emergency response and other relevant plans to reflect climate-risks and projections.
- Incorporate future climate projections and risks into regional emergency response exercises.
- Host a training series on how to incorporate resilience into all types of government plans.

How Member Jurisdictions Can Support

- Incorporate climate projections and climate risks into emergency and other government plans.
- Actively reach out to ensure participation by vulnerable groups in disaster preparedness, response, and recovery programs.
- Explore how communities outside floodplains may be impacted by sea level rise, precipitation projections, and future flood risks.
- Assess long-term energy resilience planning into energy and other plans and guidelines.
- Update zoning, building codes, ordinances, and the development review process to ensure new development is more resilient to forward-looking local climate impacts.

Region Forward Co-Benefits:

- **Public Safety and Equity:** Integrating climate strategies with emergency preparedness will enhance region's ability to prepare for and recover from disasters and meet the needs of the most vulnerable populations.
- **Economy:** Integrating climate projections into emergency plans can reduce economic damages from disasters.

EQ-3: SUPPORT ENGAGEMENT OF THE PUBLIC ON CLIMATE RISKS, WITH AN EMPHASIS ON POTENTIALLY VULNERABLE POPULATIONS

Action Overview

Metropolitan Washington is at risk to a range of threats - extreme heat, flooding, winter storms, drought, and lightning and thunderstorms. Engaging local communities to discuss climate risks and solutions is an important step to achieving common understanding of climate risks and enhancing the resilience of local communities and its people. Potentially vulnerable populations face a heightened risk to climate change while simultaneously can be the hardest groups to reach. Therefore, emphasis must be taken to strengthen engagement initiatives to these communities.

The District and the Georgetown Climate Center conducted a year-long community engagement process in the neighborhoods surrounding the Watts Branch Tributary of the Anacostia River. The effort sought to create an inclusive and empowering process where residents living in the climate-vulnerable parts of the District could self-determine a vision for a resilient and sustainable community. The project relied on an "Equity Advisory Group" (EAG) of residents that provided recommendations around the implementation of actions that support the Ward 7 residents.[cix]

Supporting A Climate Ready Region

Climate change will impact the region's most vulnerable populations disproportionately. Adapting to these risks rely heavily on the development of accessible and meaningful engagement opportunities with these populations. Typical outreach strategies may not be reaching our most vulnerable residents. Communication efforts must be expanded to ensure climate risk communications are accessible, digestible, and empower diverse communities to understand risks, and engage in the dialogue on resilience measures to ensure an equitable climate future.

Level of Implementation Needed to Address Climate Risks

All local governments need to engage the public, with an emphasis on engaging and empowering potentially vulnerable communities, to support the goal of becoming a Climate Ready by 2030. This action addresses all climate risks including extreme heat, drought, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Support information sharing of best practices and region-specific messaging for effective community outreach strategies to diverse communities.
- Provide region-wide information identifying vulnerable populations such as transportation Equity Access Areas and community level health impact data.

How Member Jurisdictions Can Support

- Integrate climate projections, risks, and strategies into existing community outreach programs.
- Further build partnerships with community groups and leaders to improve communication and engagement strategies.
- Engage potentially vulnerable communities in assessing their vulnerabilities (social, ecological, economic, public health) to climate impacts.
- Provide direct assistance (technical and financial) to potentially vulnerable populations.
- Develop metrics to measure the effectiveness of outreach efforts with diverse communities.

Region Forward Co-Benefits:

- **Equity:** As vulnerable populations are disproportionally impacted by climate impacts, furthering efforts to engage with diverse communities helps ensure a regional equitable climate future.

EQ-4: SUPPORT EQUITABLE SECURE ENERGY ACCESS

Action Overview

Energy equity ensures the fair distribution of energy supply to all residents regardless of socio-economic status, accessibility, and affordability. As the region transitions to a clean energy economy, the most vulnerable populations in our region must have access to secure and affordable clean energy to ensure an equitable climate future for all. Vulnerable populations may have less ability to respond to or recover from climate impacts. Secure and reliable energy access, especially during and after extreme events, will assist in reducing economic and social disparities in our region.

In 2019, the Arlington County Board adopted the Community Energy Plan that establishes equity as a focus to inform design, investment and implementation of the plan. The plan ensures equitable access to a clean, reliable, and secure grid for vulnerable populations and low-to-moderate income communities.[cx]

Supporting A Climate Ready Region

As climate change puts an increasing stress on energy infrastructure, ensuring systems and assets are resilient to flooding, extreme heat, and extreme weather events while providing accessible and affordable clean energy to all residents is critical to provide life-saving services before, during, and after acute events and in response to chronic conditions. Future climate impacts in metropolitan Washington will require a reliable and resilient energy system that can withstand frequent and severe climate events while delivering affordable and reliable energy to all residents including the most vulnerable in our communities.

Level of Implementation Needed to Address Climate Risks

Implementing mechanisms to ensure equitable secure energy access for all will help grow towards the goal of a climate resilient region by 2050 through empowering the notion of resilient communities. This action addresses climate risks of extreme heat, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Support information sharing of best practices for equitable access to secure, affordable clean energy.
- Advocate for state and federal actions to enhance access to secure, affordable clean energy.

How Member Jurisdictions Can Support

- Implement local government energy assurance planning initiatives in potentially vulnerable communities.
- Coordinate with utilities and promote electric grid and natural gas pipeline hardening, bulk fuel suppliers to promote resilient supply chains, and prioritize infrastructure improvements in potentially vulnerable communities.
- Prioritize microgrid deployment in potentially vulnerable communities.
- Ensure potentially vulnerable communities will have access to basic services during power outages.

Region Forward Co-Benefits:

- **Equity:** Vulnerable populations are disproportionally affected by climate impacts. Furthering efforts to provide equitable secure energy access ensures all residents have access to an equitable future.

Commented [MD10]: Additional RESF-12 priorities to add?

RI-1: SUPPORT ESTABLISHMENT OF RESILIENCE HUBS

Action Overview

A resilience hub is a community-serving accessible facility that provides community-building activities, steady state support to local residents, and life-saving resources before, during, and after climate events. Resilience hubs not only provide safe haven for residents during extreme events but provide year-round support to improve local adaptive capacity and foster community building. Additionally, resilience hubs can be energy independent, which proves vital energy supply during power outages and extreme weather events, including emergency heating and cooling, charging ability, and storing of emergency medication and equipment.[cxi]

As part of Washington D.C.'s comprehensive efforts to implement Climate Ready DC, the Department of Energy and Environment (DOEE) is working with the Ward 7 community to develop a neighborhood-scale resilience hub in a trusted space by the community. Ward 7 faces disproportional climate risks compared to the majority of the city. The resilience hub will provide yearlong community support as well as emergency services and resources during crises.[cxii]

Commented [MD11]: Since we already used a Ward 7 example, perhaps we could highlight Prince George's efforts to develop a community microgrid served hub with government services, grocery, and pharmacy services. W would need more information.

Supporting A Climate Ready Region

Vulnerable populations face an increased risk to climate hazards and may have limited resources to adapt to a changing climate. Within vulnerable neighborhoods, residents may lack access to resources necessary to prepare for and recover from climate events. During extreme events, resilience hubs can provide lifesaving supplies (food, water, power, etc.). Resilience hubs enhance social cohesion within communities by shifting power to local communities to establish community-driven climate resilience.

Level of Implementation Needed to Address Climate Risks

Establishment of resilience hubs in vulnerable communities to serve the people most impacted by climate change will help the region achieve full resilience by 2050. This action addresses all climate risks including extreme heat, drought, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Partner on grant applications and provide engineering support through regional contracts.
- Coordinate the sharing of best practices through workshops and materials (fact sheet, resource guides etc.).

How Member Jurisdictions Can Support

- Identify most climate vulnerable communities and assess the potential to establish resilience hubs in those communities.
- Leverage relationships with community organizations and leaders to identify needs of the community and implement resilience hubs and other neighborhood-scale resilience solutions.
- Partner with energy providers to develop resilience hubs with an uninterruptable energy supply.

Region Forward Co-Benefits:

- **Equity:** Resilience hubs empower local communities by shifting segments of decision-making efforts to members of the community.

RI-2: IMPROVE THE RESILIENCE OF CRITICAL INFRASTRUCTURE

Action Overview

The consequences to metropolitan Washington's energy, water, transportation, and communication systems from climate impacts are life threatening and may cause long-term physical and economic damages. Extreme events, such as Hurricane Sandy and Derecho event of 2012, severely impacted the region's ability to provide critical services during times of crisis. Priority critical infrastructure, such as hospitals and 9-1-1 centers, will need to further implement measures that increase resilience to continue to operate and serve the community during and after disasters. As climate change further strains the regions aging infrastructure, implementing measures to ensure critical infrastructure is resilient to a changing climate is essential.

As part of a comprehensive effort to ensure the resilience of critical public services during major outages, Montgomery County installed a microgrid at its Public Safety Headquarters (PSHQ). The project features 2 megawatts of solar photovoltaic parking lot canopies, an 800-kilowatt Combined Heat and Power (CHP) system, electric vehicle charging stations and a cyber security system.[cxiii]

Supporting A Climate Ready Region

As existing infrastructure ages and populations grows, infrastructure will need to be replaced, upgraded, and expanded. Climate projections show as the number of hot and cold days will be increasing, more frequent and severe extreme weather events may impact infrastructure. Water utility, and energy utility infrastructure that already incur sizable maintenance costs and risks may face an increased strain and will require upgrades and design standards that take into consideration future climate projections.

Level of Implementation Needed to Address Climate Risks

Assessing critical infrastructure now is essential in order to establish the necessary actions to ensure all critical infrastructure and functions as climate resilient in the region by 2050. This action addresses all climate risks including extreme heat, drought, flooding (flash, riverine, and coastal), lightning/ thunderstorms and extreme winter conditions.

How COG Can Support

- Support systematic planning for protection of critical infrastructure identified through the COG Critical Infrastructure Working Group.
- Increase capacity to utilize Federal Emergency Management Agency (FEMA) Pre-Disaster Mitigation Program funding and identify other sources of funding.
- Coordinate the sharing of feasibility studies and best practices for measures to increase resilience of critical infrastructure.
- Partner with local governments on risk studies.

How Member Jurisdictions Can Support

- Assess vulnerability of critical infrastructure for transportation, communication, energy, and water system assets.
- Flood proof critical water, stormwater, and wastewater systems to reflect climate projections.
- Revise infrastructure design standards to be more resilient to heat, flooding, and other climate impacts.

Region Forward Co-Benefits:

- **Public Safety:** Implementing resilient measures to existing infrastructure ensures public safety entities can provide lifesaving services during extreme events.

RI-3: IMPLEMENT MEASURES TO EQUITABLY ADDRESS URBAN HEAT ISLAND

Action Overview

Heat is one of the leading causes of weather-related injuries and fatalities in metropolitan Washington. As extreme heat days become more prevalent, the region will face a high threat from extensive heat waves. Extensive development within metropolitan Washington has resulted in a significant number of areas with impervious surfaces and limited tree canopy. Populations residing in these areas, especially vulnerable peoples, will be more severely impacted by extreme heat. [cxiv]

The District of Columbia is taking many steps to reduce the impacts of the urban heat island effect. The District's Urban Tree Canopy Plan aims to increase a healthy tree canopy cover to 40 percent by 2032. The District's RiverSmart Green Roof Rebate Program offers rebates between $10-15 per square foot to promote the voluntary installation of green roofs. The green roofs help reduce the urban heat island effect and improve stormwater management practices.[cxv]

Supporting A Climate Ready Region

Extended periods of extreme heat can result in loss of human life, power outages, and infrastructure damages. The elderly, low-income persons, persons with allergies and underlying health conditions are especially vulnerable to extreme heat. As development increases in metropolitan Washington, incorporating cooling strategies that prioritizes vulnerable populations is essential to reduce the urban heat island effect. Implementing passive cooling mechanisms such as tree canopy and vegetation will substantially reduce risks to human life without increasing the regions reliance on energy. [cxvi]

Level of Implementation Needed to Address Climate Risks

Reducing the impacts of extreme heat and the urban heat island effect assists the region in becoming Climate Ready by 2030. This action primarily addresses the climate risk of extreme heat but can also flooding (flash, riverine, and coastal) risks.

How COG Can Support

- Strategically coordinate the planting of new trees to expand the regional tree canopy to lower ambient air temperatures during summer months.[cxvii]
- Prioritize and assess funding opportunities for implementation measures including cool and green roofs, and green walls.
- Support urban heat island and vulnerability mapping across the region.

How Member Jurisdictions Can Support

- Develop thermal mapping to identify urban heat island hot spots, impacted vulnerable populations, and potential areas for mitigation strategies.
- Assess existing and future cooling centers based on extreme heat projections and needs of vulnerable populations. Consider factors including accessibility, language interpreters, backup power support, medical assistance, and food and water supplies.
- Support urban forestry programs to maximize tree canopy in vulnerable communities.
- Implement cool and green roofs, and green walls.

Region Forward Co-Benefits:

- **Health and Human Services:** Urban tree canopy can improve air quality, reduce mental distress, and may have positive health effects.[cxviii]
- **Equity:** Tree planting should be prioritized in vulnerable communities with limited access to parks and green spaces.[cxix]

RI-4: ENHANCE GREEN INFRASTRUCTURE NETWORKS

Action Overview

Protections against climate-driven risks can take the form of hard infrastructure improvements such as flood walls or constructing resilience hubs, or nature-based, resilient green infrastructure networks to restore and manage natural ecosystem functions to increase capacity to adapt to a changing climate. Green infrastructure is an interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other important natural areas. An interconnected system of natural areas protects biodiversity, enhances natural community resiliency, and buffers the impacts of development—all while providing multiple public benefits. In some contexts, the term green infrastructure refers to low impact development and stormwater management, or recreational trail networks. For the purposes of this measure, green infrastructure relates to land cover and waterways.[cxx]

There are several ways to enhance nature-based, resilient green infrastructure network, such as green infrastructure plans, natural resource management plans, or green space plans. Prince George's County's Green Infrastructure Plan identifies existing green infrastructure elements throughout the county and proposes conservation mechanisms to preserve, protect, and enhance these elements. Fairfax County Natural Resource Management Plan focuses on protecting and enhancing natural capital, restoring ecosystems and fostering stewardship.[cxxi]

Supporting A Climate Ready Region

Resilient green infrastructure can reduce the need for hard infrastructure improvements. The region has existing nature-based protections, such as the parkland located along many of the region's waterways and existing urban tree canopy that can be expanded on.

Level of Implementation Needed to Address Climate Risks

Resilient green infrastructure can reduce the impacts of extreme heat and flooding to support the region in becoming Climate Ready by 2030.

How COG Can Support

- Work with partners to evaluate coastal, inland and overland flooding risks and options to use green infrastructure and natural systems to reduce climate risks.

How Member Jurisdictions Can Support

- Design and plan for resilient green infrastructure before development occurs.
- Implement a plan to preserve and enhance ecologically valuable green spaces in urban, suburban and rural areas, such as a green infrastructure plan, natural resource management plan, or green space plan.
- Invest in nature-based, resilient green infrastructure network solutions to reduce risk from flooding and extreme heat.

Region Forward Co-Benefits:

- **Equity:** Resilient green infrastructure enhancements should be prioritized in vulnerable communities with limited access to parks and green spaces.

RI-5: IMPLEMENT MEASURES TO REDUCE FLOOD RISKS

Action Overview

Changes in the frequency and severity of flooding, and sea level rise will require the region to adapt to an increasing flood risks that threatens the regions ability to provide water, energy, and transportation services. Reducing risks to flooding is heavily influenced by the amount and type of development, shore protection measures, site and building design, stormwater drainage infrastructure, nature-based solutions (wetlands, vegetation, etc.), structural (floodwalls, levees, bulkheads etc.,) and non-structural measures (relocation, zoning and flood insurance) and other resilience flood measures. The region relies on shared infrastructure for water, communications, energy, and transportation services; therefore, each entity/system within our region is only as protected as the weakest link in the regional infrastructure system.[cxxii]

The City of Alexandria is undertaking a multi-year capital flood project on the city's waterfront to reduce flooding and improve stormwater collection and transport. Some of the measures include elevating areas that frequently flood, a new bulkhead and elevated walkway, and integrating low flood walls to protect against the 10-year flood.[cxxiii]

Supporting A Climate Ready Region

Flooding is a main hazard of concern in metropolitan Washington. More frequent and severe precipitation events and water level rise, aging infrastructure, and rapid development and population growth will strain stormwater and sewer collection systems. The impacts of flooding are expected to be exacerbated with a changing climate, leading to asset damage and deterioration, threatening operability of critical infrastructure, increasing stormwater runoff, and property damage.

Level of Implementation Needed to Address Climate Risks

Incorporating measures to reduce flood risks green can reduce the impacts of flooding and support the region in becoming Climate Ready by 2030.

How COG Can Support

- Work with partners to evaluate coastal, inland and overland flooding risks and options to reduce flood risks.
- Support legislation and funding opportunities that address flood control and management, water quality programs, and stormwater management in the region.

How Member Jurisdictions Can Support

- Identify at-risk facilities based on flooding and sea level rise. Prioritize resilience strategies based on age of facilities and critical need.
- Incorporate nature-based solutions, non-structural, and structural measures strategies to reduce flood risks.
- Increase the resilience of water, stormwater, and wastewater system. Secure investments for green and grey infrastructure to improve the capacity of these systems.
- Prioritize existing properties vulnerable to flooding for buyout programs and easements.
- Adopt and implement green street policies and programs.

Region Forward Co-Benefits:

- **Economy and Equity:** Incorporating resilience measures can limit the financial impacts of flooding events and reduce the burden to vulnerable populations.
- **Health and Human Services:** Incorporating resilience measures can decrease pollution from stormwater runoff into rivers and streams and reduce associated adverse health impacts.

Mitigation-Resilience Co-Benefits

Responding to climate change requires addressing both mitigation and resilience strategies. Mitigation strategies primarily focus on reducing the causes of climate change, while resilience strategies center around limiting the impacts of climate change and adapting to a new climate. Many of the mitigation and resilience actions provide co-benefits that reduce greenhouse gas emissions and reduce vulnerabilities to the negative consequences of climate change.

As climate events become more severe and frequent, incorporating actions that have both mitigation and resilience benefits is even more invaluable. This is addressed in a number of areas in this Plan.

- Efforts to enhance tree canopy provides both mitigation benefits via carbon sequestration and reduced energy consumption due to shading during the cooling season and resilience benefits via minimizing the urban heat island effect. Additionally, efforts to enhance tree canopy provide water quality environmental benefits as it reduces stormwater runoff into surface waters and enhances the qualities of and increases the value of open space.
- Public education efforts about climate change can use resiliency risks as a more tangible example of why climate change should be addressed. The longer-term benefits of mitigation may be less apparent to the public. Using resiliency, particularly tied to current events, such as floods from heavy summer storms or hurricanes, a derecho, or the increased western United States fires, as a way to open the door can more effectively enable people to see the direct effects on their lives. This then can be used to motivate mitigation action.
- Resilience hubs both can provide a short-term benefit to communities during an acute event and serve as an example of mitigation actions. One factor driving adoption of distributed solar is the presence of other distributed solar in a community. New adopters may become more comfortable to adopt the technology when the see neighbors, either houses or businesses, successfully using on-site solar. Incorporating on-site solar into resiliency hubs serves to address resiliency risks and meet mitigation goals.
- Accelerating deployment of battery storage similarly serves both resiliency and mitigation goas. Battery storage improves resiliency by providing for emergency power when alternative energy systems cannot produce. They also enhance mitigation as they can increase the use of renewable energy by storing excess generation for later use.
- Property Assessed Clean Energy (PACE) financing is one tools to increase the adoption of deep building retrofits, an important mitigation goal. PACE financing is now eligible in some jurisdictions as a funding source for resiliency improvements such as floodproofing.
- One of the keys to market circularity is to use what otherwise would be a waste material as an input to other systems. One method to provide for circularity is to provide energy production from wastes. These actions can reduce net greenhouse gas emissions while providing an electricity source that can serve as a black-start resource if needed after loss electric generation and transmission. In its simplest form, black-start resources are able to start when the rest of the grid goes dark, which can then be used to bring the rest of the grid's resources back online.

This discussion address some of the co-benefits of mitigation and resiliency strategies. As is true of most systems, energy systems are so inter-related that other mitigation actions will enhance resiliency, and vice-a-versa, although in a less direct manner.

CONCLUSIONS

Climate change is a major environmental issue affecting both human health and natural ecosystems. COG's Climate and Energy Program is one of the nation's first initiatives to address climate change on a regional level. The regional effort is led by the Climate, Energy and Environment Policy Committee (CEEPC) and guided by this Action Plan. Communities in the region are already implementing renewable energy and energy efficiency initiatives, facilitating electric vehicle adoption, and other programs to help reduce greenhouse gas (GHG) emissions. This Action Plan further provides a roadmap for collaborative action by COG, its members and stakeholders communities to facilitate a move toward zero energy buildings, zero emission vehicles, and zero waste. COG will continue to work with its regional partners to meet the 2030 goals of reducing GHG emissions 50 percent below the 2005 levels and becoming a Climate Ready Region. The next ten years of action will set the stage for the 2050 vision for a carbon neutral, resilient metropolitan Washington.

APPENDICES

See separate attachment for appendices.

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METROPOLITAN WASHINGTON 2030 CLIMATE AND ENERGY ACTION PLAN - DRAFT

Appendices

This document is a compilation of Appendices prepared for the Metropolitan Washington 2030 Climate and Energy Action Plan.

September 2020

Metropolitan Washington Council of Governments

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APPENDIX A: STRATEGIES SUMMARY TABLES

Climate Mitigation Strategy Actions

Climate Action Area	Action ID	Priority Collaborative Action
Planning	PL - 1	Advance Climate Planning and Track Progress
Equity	EQ - 1	Enable Equitable Planning Practices
	EQ - 2	Prioritize Sustainable Energy Access for All
Clean Electricity	CE - 1	Advocate for Aggressive Renewable Portfolio Standards
	CE - 2	Accelerate Development of On-Site Renewables
	CE - 3	Accelerate Deployment of Battery Storage
	CE - 4	Accelerate Development of Microgrids for Critical Infrastructure
	CE - 5	Accelerate Development of Large-Scale Off-Site Renewables
	CE - 6	Advocate for and Implement Community Choice Aggregation
Zero Energy Buildings	ZEB - 1	Expand Building Benchmarking Requirements
	ZEB - 2	Accelerate Deep Building Retrofits
	ZEB - 3	Enhance Green Building Codes and Policies to Facilitate Net Zero Energy Building Development
	ZEB - 4	Expand Proper Disposal and Leak Detection of Refrigerants
Zero Emission Vehicles	ZEV - 1	Expand Light-Duty Electric Vehicle Deployment
	ZEV - 2	Accelerate Electrification of Medium- and Heavy-Duty Vehicles
	ZEV - 3	Build Out Regional Electric Vehicle Charging Network
Zero Waste	ZW - 1	Implement Curbside Organics Recycling Programs
	ZW - 2	Reduce Solid Waste Generation
	ZW - 3	Build Markets for Circularity
Sequestration	SQ - 1	Strategically Plant New Trees on Publicly Owned Land
	SQ - 2	Enhance Regulatory Capacity to Manage Tree Canopy and Forest Protection
	SQ - 3	Enhance Tree Planting and Preservation on Privately Owned Lands

Climate Resilience Strategy Actions

Climate Action Area	Action ID	Priority Collaborative Action
Planning	PL - 2	Support Capacity Building for Climate Resilience Planning
	PL - 3	Develop Integrated Approach to Climate Resilience Planning
	PL - 4	Update Local Regional Plans to Address Climate Risks
Equity	EQ - 3	Support Engagement of the Public on Climate Risks, with a Particular Emphasis on Potentially Vulnerable Populations
	EQ - 4	Support Equitable Secure Energy Access
Resilient Infrastructure	RI - 1	Support Establishment of Resilience Hubs
	RI - 2	Improve the Resilience of Critical Infrastructure
	RI - 3	Implement Measures to Equitably Address Urban Heat Island
	RI - 4	Enhance Green Infrastructure Networks
	RI - 5	Implement Measures to Reduce Flood Risk

APPENDIX B: TERMS AND DEFINITIONS

Terms	Definitions
Adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. (GCoM) Adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities. (EPA)
Adaptive Capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences. (GCoM)
Anaerobic Digestion	Anaerobic digestion is the natural process in which microorganisms break down organic materials. Anaerobic digestion happens in closed spaces where there is no air (or oxygen). Biogas is generated during anaerobic digestion. Biogas is mostly methane (CH_4) and carbon dioxide (CO_2), with very small amounts of water vapor and other gases. Biogas can be used to power engines and produce electricity and/or heat. (EPA)
Battery Storage	Battery storage is a technology that enables power system operators or utilities to store energy for later use. A battery storage system charges or collects energy from the grid or distributed resource (i.e. solar panels) and discharges that energy at a later time to provide electricity or other grid services when needed. (NREL)
Building Benchmarking	Benchmarking is the practice of comparing the measured performance of a device, process, facility, or organization to itself, its peers, or established norms, with the goal of informing and motivating performance improvement. When applied to building energy use, benchmarking serves as a mechanism to measure energy performance of a single building over time, relative to other similar buildings, or to modelled simulations of a reference building built to a specific standard (such as an energy code). (DOE)
Business as Usual (BAU)	Business as usual projections are based on the assumption that operating practices and policies remain as they are at present. Although baseline scenarios could incorporate some specific features of BAU scenarios (e.g., a ban on a specific technology), BAU scenarios imply that no practices or policies other than the current ones are in place. (IPCC)

Carbon Offset	A credit or financial instrument that an individual, organization, or other entity may purchase to negate carbon emissions. Revenue from carbon offsets are typically used to fund climate change mitigation or adaptation efforts. (ICLEI)
Carbon Neutral	Achieving a state in which the net amount of carbon dioxide or other carbon compounds emitted into the atmosphere is reduced to zero because it is balanced by actions to reduce or offset these emissions. (Sustainable DC 2.0) Refers to achieving net zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset or buying enough carbon credits to make up the difference. (Cleantech Rising) Carbon neutrality means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Removing carbon oxide from the atmosphere and then storing it is known as carbon sequestration. In order to achieve net zero emissions, all worldwide greenhouse gas emissions will have to be counterbalanced by carbon sequestration. (IPCC)
Carbon Sequestration	The process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change. (USGS)
Carbon Tax	A carbon tax directly sets a price on carbon by defining a tax rate on greenhouse gas emissions or – more commonly – on the carbon content of fossil fuels. It is different from an Emissions Trading System (ETS) in that the emission reduction outcome of a carbon tax is not pre-defined but the carbon price is. (World Bank Group)
Circular Economy	A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models. (World Economic Forum) Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles: • Design out waste and pollution • Keep products and materials in use • Regenerate natural systems (Ellen MacArthur Foundation)

Clean/Green Economy	An economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. An economy that is low carbon, resource efficient, and socially inclusive. (UNEP) An economy that decouples economic growth from carbon emissions. (COG)
Clean/Green Power	A subset of renewable energy and represents those renewable energy resources and technologies that provide the highest environmental benefit by reducing the emissions associated with traditional electricity sources. (EPA) A generic term for renewable energy sources and specific clean energy technologies that emit fewer GHG emissions relative to other sources of energy that supply the electric grid. Includes solar photovoltaic panels, solar thermal energy, geothermal energy, landfill gas, low-impact hydropower, and wind turbines. (ICLEI)
Climate Change	Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. (EPA)
Coastal Flood	A coastal flood, or the inundation of land areas along the coast, is caused by higher than [average] high tide and worsened by heavy rainfall and onshore winds (i.e., wind blowing landward from the ocean). (NOAA)
Co-Benefit	The benefits of policies that are [implemented] for various reasons at the same time including climate change mitigation acknowledging that most policies designed to address greenhouse gas mitigation also have other, often at least equally important, rationales (e.g., related to objectives of development, sustainability, and equity). (EPA)
Combined Heat and Power (CHP)	CHP systems use the same energy source to simultaneously produce useful thermal energy and electricity or mechanical power in an integrated system. A variety of technologies can be used for CHP, including reciprocating engines, combustion turbines, steam turbines, organic rankine cycle turbines and fuel cells. (COG)
Community Choice Aggregation (CCA)	Community Choice Aggregation (CCA) are programs that allow local governments to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider. CCAs are an attractive option for communities that want more local control over their electricity sources, more green

	power than is offered by the default utility, and/or lower electricity prices. By aggregating demand, communities gain leverage to negotiate better rates with competitive suppliers and choose greener power sources. (EPA)
Community Solar	A solar energy facility that allows multiple people to subscribe and benefit from the energy output of the facility. (Adapted from Pathways to 100)
Consequence	In a Climate, Risk and Vulnerability Assessment, consequence is the outcome/impact/gravity of an identified climate hazard (i.e. extreme heat, flooding, etc.). A high consequence represents a high or the highest level of potential concern for the community and results in serious impacts and (catastrophic) interruptions to day-to-day life. A moderate consequence represents a moderate level of potential concern and impacts to the community are moderately significant to day-to-day life. A low consequence represents a lower (the lowest) level of potential concern to the community and impacts are deemed less significant (or insignificant) to day-to-day life. The future risk level is determined by probability x consequence and expected change in intensity, frequency, and timescale of expected changes. See definitions for impact, probability and risk. (GCoM)
Critical Infrastructure	Critical infrastructure describes the physical and cyber systems and assets that are so vital to the United States that their incapacity or destruction would have a debilitating impact on our physical or economic security or public health or safety. (DHS)
Decarbonization	The transition from high-carbon emissions producing energy sources to low- or zero- carbon energy sources. (Pathways to 100)
Distributed Energy Generation	Small-scale generation resources that feed directly into distribution portions of the electric grid (e.g., rooftop solar). (Pathways to 100)
Drought	Drought is what happens when rainfall is lower than normal [for] a long time. Droughts can last a single season, a whole year, or for many years and can affect a few hundred or millions of square miles. (CDC)
EarthCraft	EarthCraft is a high-performance building certification program developed to address the challenging energy, water and climate conditions in the Southeast. EarthCraft offers Communities, House, Light Commercial, Multifamily, Renovation, and Sustainable Preservation programs. (EarthCraft)
Electric Grid	The electricity grid is a complex machine in which electricity is generated at centralized power plants and decentralized units and is transported through a system of substations, transformers and transmission lines that deliver the product to its end-user, the consumer. (EPA)

Electric Vehicle	There are two primary types of Electric Vehicles: 1) Plug-in Hybrid Electric Vehicles (PHEVs) and, 2) Battery Electric Vehicles (BEVs) or All-Electric Vehicles (AEVs). PHEVs have an Internal Combustion Engine (ICE) that is used once the battery has been depleted. BEVs/AEVs do not have an ICE and rely solely on electricity from a battery. (Adapted from Cadmus Pathways to EV)
Electric Vehicle (EV)-Ready Building Codes	EV-Ready Building Codes are rules and regulations that dictate how EV charging stations must be constructed in residential and commercial buildings. They are used to ensure that the building's electrical capacity is adequate and other infrastructure is in place to facilitate the possibility of a charging station, so that buildings are 'ready' for their installation in the future. (ChargePoint)
Electric Vehicle Supply Equipment (EVSE)	Electric Vehicle Supply Equipment (EVSE) is used to supply electric energy to recharge electric vehicles. EVSEs are also known as EV charging stations, electric recharging points or just charging points. EVSEs can provide a charge for the operation of electric vehicles or plug-in hybrid electric-gasoline vehicles. (Mr. Electric) Charging stations have different levels to charge your vehicle: Level 1, Level 2, Level 3 DC Fast Charging, and Tesla Supercharging (which only charges Tesla vehicles). All electric cars can charge on Level 1 and Level 2 options. However, some vehicles cannot charge at a Level 3 charger. Knowing your vehicle's capabilities is therefore very important. (EVgo)
Emissions Forecast	Estimates of future year emissions determined by projecting the effects of economic growth and existing regulations on future year emission inventories. The forecasts can be used for a variety of purposes including modeling of future air quality, assessing the effectiveness of proposed control measures, analyzing new source impacts, and tracking progress towards clean air. (Imperial County Air Pollution Control District)
Emissions Inventory	An estimate of the amount of pollutants emitted into the atmosphere from major mobile, stationary, area-wide and natural source categories over a specific period of time such as a day or a year. (California Air Resources Board) A comprehensive, quantified list of a community's or organization's GHG emissions and sources. (ICLEI)
Emissions Per Capita	The total amount of greenhouse gas emitted by a country per unit of population. (BBC)
Emissions Scenario	A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse

	gases, aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections. (IPCC) A "What Would It Take" scenario is a goal-oriented scenario that tries to answer the question of what it would take to meet a specified greenhouse gas emission reduction goal. (COG)
Emissions Trading System (ETS)	An ETS – sometimes referred to as a cap-and-trade system – caps the total level of greenhouse gas emissions and allows those industries with low emissions to sell their extra allowances to larger emitters. By creating supply and demand for emissions allowances, an ETS establishes a market price for greenhouse gas emissions. The cap helps ensure that the required emission reductions will take place to keep the emitters (in aggregate) within their pre-allocated carbon budget. (World Bank Group)
Energy Access	Energy access refers to "access to secure, sustainable, and affordable energy." Energy access typically includes the following three components: 1. Access to secure energy: Reduce energy demand, diversify the energy mix with the largest possible share of renewable energy sources, and lower dependence on imported energy and diversify energy supply sources. 2. Access to sustainable energy: Provide access to grid-based and decentralized renewable energy. Ensure that, where there is currently no access to energy, renewable energy sources are considered first. 3. Access to affordable energy: Utilize policies, including subsidies or other incentive mechanisms, to promote access to renewable energy systems and energy efficiency and conservation. (GCoM)
Energy Efficiency	Energy efficiency reduces the amount of energy needed to provide the same or improved level of service. Common energy efficiency measures include hundreds of technologies and practices for practically all end-uses across all sectors of the economy. (EPA)
Energy Intensity	The quantity of energy required per unit output or activity, so that using less energy to produce a product reduces the intensity. (DOE)
Energy Poverty	A situation where a household or an individual is unable to afford basic energy services (heating, cooling, lighting, mobility and power) to guarantee a decent standard of living due to a combination of low income, high energy expenditure and low energy efficiency of their homes. (European Commission)

ENERGY STAR	ENERGY STAR is a program run by the U.S. EPA and U.S. DOE that promotes cost-saving energy efficient solutions that improve air quality and protect the climate. ENERGY STAR certified products are independently certified to deliver efficiency performance and savings to consumers. ENERGY STAR provides tools and resources for buildings and plants to save energy, increase profits, and strengthen competitiveness. ENERGY STAR's Portfolio Manager is a tool commonly used by businesses to track energy, water, and/or waste and materials in their buildings. (ENERGY STAR)
Energy Use Intensity	Energy per square foot per year. Calculated by dividing the total energy consumed by the building in one year (measured in kBtu or GJ) by the total gross floor area of the building. (EnergyStar)
Environmental Justice	The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. (EPA)
Equity	Equity is a principle that calls for fairness, inclusion and justice. It can be distinguished from the principle of diversity, which is primarily about variety. Equitable policies often require concrete actions and steps beyond simply making everyone "equal before the law," and accordingly are designed to take appropriate account of historical and contemporary injustices and unequal outcomes. (NAACP) Environmental equity means protection from environmental hazards as well as access to environmental benefits, regardless of income, race, and other characteristics. (UCLA)
Equity Emphasis Areas (EEAs)	EEAs are small geographic areas in metropolitan Washington that have significant concentrations of low-income, minority populations, or both. (COG)
Exposure	The presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure or economic, social or cultural assets in places and settings that could be adversely affected by climate change. (GCoM).
Extreme Heat	Extreme heat is defined as summertime temperatures that are much hotter and/or humid than average. (CDC)
Extreme Winter Conditions	A winter storm is a combination of heavy snow, blowing snow and/or dangerous wind chills. A winter storm is life-threatening. *Blizzards* are dangerous winter storms that are a combination of blowing snow and wind resulting in very low visibilities. While heavy snowfalls and severe cold often accompany blizzards, they are not required. Sometimes strong winds pick up snow that has already fallen,

	creating a ground blizzard. An *ice storm* is a storm which results in the accumulation of at least .25" of ice on exposed surfaces. They create hazardous driving and walking conditions. Tree branches and power lines can easily snap under the weight of the ice. *Snow squalls* are brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant. Snow squalls are best known in the Great Lakes region. (NOAA)
Flash Flood	A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through riverbeds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam. (NOAA)
Flood	An overflow of water onto normally dry land. The inundation of a normally dry area caused by rising water in an existing waterway, such as a river, stream, or drainage ditch. Ponding of water at or near the point where the rain fell. Flooding is a longer term event than flash flooding: it may last days or weeks. (NOAA)
Fugitive Emissions	Non-stack emissions that escape during material transfer, from buildings that contain the process, or directly from process equipment. (EPA) Emissions that are not physically controlled but result from the intentional or unintentional release of GHGs. They commonly arise from the production, processing, transmission, storage and use of fuels or other substances, often through joints, seals, packing, gaskets, etc. Examples include hydrofluorocarbons (HFCs) from refrigeration leaks, SF6 from electrical power distributors, and CH4 from solid waste landfills. (ICLEI)
Green Building Codes	Green Building Codes or Standards are used to enforce requirements that increase the environmental performance of buildings. There are a number of different codes that achieve this including, the International Green Construction Code (IgCC), the International Energy Conservation Code (IECC), the ASHRAE Standard, etc. (EPA)
Greenhouse Gas (GHG) Emissions	Sometimes known as "heat trapping gases," greenhouse gases are natural or manmade gases that trap heat in the atmosphere and contribute to the greenhouse effect. Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and fluorinated gases. (EPA) Greenhouse gas emissions are gases that trap heat in the atmosphere. Some greenhouse gases such as carbon dioxide occur naturally and are emitted into the atmosphere through natural

	processes and human activities. Other greenhouse gases are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases (hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride). (ICLEI)
GHG Emission Sources and Associated Activities	GHG emission sources are any physical process or activity that releases GHG emissions into the atmosphere. Examples of emission sources include vehicle exhaust from combustion of gasoline, furnace exhaust from the combustion of natural gas, power plant exhaust from the combustion of coal for the production of electricity, fugitive emissions from leaking refrigerants, and methane emissions from a landfill. Activities associated with GHG emission sources are human activities that result in the production of GHG emissions. An example is electricity use, which requires the generation of electricity at a power plant that may produce a quantity of GHG emissions in the process of generating the electricity. (ICLEI)
Green Bank	A Green Bank is a dedicated public or non-profit finance entity designed to drive private capital into market gaps. It is a finance institution dedicated to increasing and accelerating investment in clean power goods and services. Its mission is to use finance tools to mitigate climate change. Unlike typical "banks" it does not take deposits, and its operations can be funded by governments or charitable contributions or both. It may deploy capital from public or private sources, invest on its own or in conjunction with private sector investors. (Coalition for Green Capital)
Green Bonds	A green bond is a bond specifically earmarked to be used for climate and environmental projects. These bonds are typically asset-linked and backed by the issuer's balance sheet and are also referred to as climate bonds. Green bonds are designated bonds intended to encourage sustainability and to support climate-related or other types of special environmental projects. More specifically, green bonds finance projects aimed at energy efficiency, pollution prevention, sustainable agriculture, fishery and forestry, the protection of aquatic and terrestrial ecosystems, clean transportation, sustainable water management and the cultivation of environmentally friendly technologies. (Investopedia)
Grid-Connected Renewable Energy System	A grid-connected system allows you to power your home or small business with renewable energy during those periods (daily as well as seasonally) when the sun is shining, the water is running, or the wind is blowing. Any excess electricity you produce is fed back into the grid. (DOE)
Hazard	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury or other health impacts, as well as damage and loss to property,

	infrastructure, livelihoods, service provision, ecosystems, and environmental resources. The term hazard usually refers to climate-related physical events or trends or their physical impacts. (GCoM)
Heat Wave	Prolonged periods of extreme heat. (CDC) A heat wave is a period of unusually hot weather that typically lasts two or more days. To be considered a heat wave, the temperatures have to be outside the historical averages for a given area. (NOAA)
Hurricane	A hurricane is a type of storm called a tropical cyclone, which forms over tropical or subtropical waters. A tropical cyclone is a rotating pressure weather system that has organized thunderstorms but no fronts (a boundary separating two air masses of different densities). Tropical cyclones with maximum sustained surface winds of less than 39 miles per hour (mph) are called tropical depressions. Those with maximum sustained winds of 39 mph or higher are called tropical storms. When a storm's maximum sustained winds reach 74 mph, it is called a hurricane. The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating, or category, based on a hurricane's maximum sustained winds. (NOAA)
Hybrid Electric Vehicle (HEV)	HEVs have an Internal Combustion Engine (ICE) and no plug-in capability. The “electric” component of HEVs is derived from the charging of a battery via regenerative braking, which reduces gasoline consumption. (Adapted from Cadmus Pathways to EV)
Impact	Climate change impacts are effects of extreme weather and climate events and of climate change on humans and natural systems. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. (GCoM)
Kigali Amendment	The Kigali Amendment to the Montreal Protocol is an international agreement between 99 countries and the European Union to gradually reduce the consumption and production of HFCs, the group of chemicals most commonly used today for refrigeration. The United States has not ratified the Kigali Amendment. Following the implementation of the Montreal Protocol, hydrofluorocarbons (HFCs) gradually replaced chlorofluorocarbons (CFC’s) because of their minimal impact on the Ozone layer, having an Ozone depletion potential of zero. However, HFC’s are potent greenhouse gases (HFC’s are 3,830 times more potent than CO_2) with high global warming potentials. (UN Environment Programme)
LEED	LEED (Leadership in Energy and Environmental Design) is a green building certification program developed by the U.S. Green Building

	Council (USGBC). It provides verification of a building or neighborhood's green features, allowing for the design, construction, operations and maintenance of resource-efficient, high-performing, healthy, cost-effective buildings. (USGBC)
Lightning	Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air [acts] as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When the opposite charges build up enough, this insulating capacity of the air breaks down and there is a rapid discharge of electricity that we know as lightning. The flash of lightning temporarily equalizes the charged regions in the atmosphere until the opposite charges build up again. Lightning can occur between opposite charges within the thunderstorm cloud (intra-cloud lightning) or between opposite charges in the cloud and on the ground (cloud-to-ground lightning). (NOAA)
Living Buildings Challenge	The Living Building Challenge framework helps to create spaces that reconnect occupants with nature by creating buildings that generate more energy than they use, capture and treat all water on site, and are made using healthy materials. (Living Future Institute)
Microgrids	Microgrids are small-scale electricity distribution systems that link and coordinate multiple distributed energy resources into a network serving some or all of the energy needs of one or more users located in close proximity, which can operate connected to the traditional centralized electric grid or autonomously from it, in an intentional island mode. (COG)
Mitigation	A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. (EPA)
Net Metering	A state policy allowing a single customer to apply credits earned from excess generation at one site where electricity is generated towards the electricity bill for a second geographically distinct account, also sometimes referred to as Virtual Net Metering. (Pathways to 100)
Net Zero City/Community	A community of buildings for which, on an annual basis, all greenhouse gas emissions produced through building operations are offset by carbon-free energy production. (Cambridge, MA)
	The total amount of energy used by the entire infrastructure of the city on an annual basis is roughly equal to the amount of renewable energy created on the site, or nearby. That includes energy used by all vehicles, construction, public works, buildings, homes, maintenance, etc. Every kWh of energy that the city uses, it would need to produce and/or offset at an equal equivalent. (Solarponics Energy Management Systems)

Net Zero Energy Buildings	Buildings that produce at least as much energy as they consume on an annual basis. They do this by incorporating state-of-the-art energy efficiency and renewable energy technologies. (NREL) A residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. (NREL)
Offsets	Credits issued for real, permanent, and verified emissions reductions that are enforceable. Organizations may purchase credits (offsets) to address direct and indirect emissions associated with their operations (e.g., emissions from a boiler used to heat an office building). The reduction in GHG emissions from one place can be used to "offset" the emissions taking place somewhere else. (EPA)
Organic Composting	Compost is organic material that can be added to soil to maintain healthy, fertile soils. Food scraps and yard waste together currently make up more than 28 percent of what we throw away, which could be composted instead. Organic composting keeps these materials out of landfills where they take up space and release methane, a potent greenhouse gas. (EPA)
Passive House	Passive House is a building standard developed by the Passive House Institute US (PHIUS) that promotes high-performance passive building standards. PHIUS certifies and quality assures passive buildings. These buildings use 40-60 percent less energy for space conditioning than conventional buildings. (PHIUS)
Power Purchase Agreement (PPA)	A contract to buy electricity over a given term. More recently, it is used to refer to the financing mechanism enabling a third party (such as a renewable energy developer) to build, own, and operate a renewable energy system on behalf of the customer upon whose roof the project is located. The host avoids the upfront and operating costs of renewable energy, and purchases the electricity generated from the third-party owner. (Pathways to 100)
Probability	In a Climate, Risk and Vulnerability Assessment, probability is the likelihood of occurrence for a climate hazard (i.e. extreme heat, flooding, etc.). A high probability of climate hazard means that it is extremely likely that the hazard occurs (i.e. greater than 1 in 20 chance of occurrence). A moderate probability of a climate hazard means it is likely to occur (i.e. between a 1 in 20 and 1 in 200 chance of occurrence). Low probability means the hazard is unlikely to occur (i.e. between a 1 in 200 and 1 in 2,000 chance of occurrence). The future risk level is determined by probability x consequence and expected change in intensity, frequency, and timescale of expected changes. See definitions for consequence and risk. (GCoM)

Property Assessed Clean Energy (PACE)	The property assessed clean energy (PACE) model is an innovative mechanism for financing energy efficiency and renewable energy improvements on private property. There are programs that exist for commercial properties (C-PACE) and residential properties (R-PACE). PACE programs allow a property owner to finance the up-front cost of energy or other eligible improvements on a property and then pay the costs back over time through a voluntary assessment. The unique characteristic of PACE assessments is that the assessment is attached to the property rather than an individual. (DOE)
Recycling	Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. (EPA)
Renewable Energy	Renewable energy comes from sources that replenish themselves over time. Renewable energy definitions vary by state, but usually include solar, wind, geothermal, biomass, biogas, and low-impact hydroelectric power. (EPA)
Renewable Energy Certificates (RECs)	A tradable commodity representing the environmental benefits of electricity generated from renewable sources. In states with an RPS, RECs are purchased and sold as a compliance mechanism. (Pathways to 100) A legal certificate verifying the purchase or use of renewable energy, whether that renewable energy is installed on the organization's facility or purchased from elsewhere. RECs play an essential role in accounting and assigning ownership to the attributes of renewable electricity generation, including the emissions profile of that generation, to their owner. REC owners can quantify the purchased electricity associated with RECs as zero-emissions electricity. (EPA) A market tradable commodity that represents proof that one megawatt-hour (MWh) of electricity was generated from a third-party verified renewable energy resource, such as a solar renewable energy certificate (SERC) that is generated from solar energy resource. (ICLEI)
Renewable Natural Gas (RNG)	RNG is derived from biomass or other renewable resources and is a pipeline-quality gas that is fully interchangeable with conventional natural gas. (Washington Gas)
Renewable Portfolio Standard (RPS)	A renewable portfolio standard (RPS) is a regulatory mandate to increase production of energy from renewable sources such as wind, solar, biomass and other alternatives to fossil and nuclear electric generation. States often design them to drive a particular technology by providing "carve out" provisions that mandate a certain

	percentage of electricity generated comes from a particular technology (e.g. solar or biomass). (NREL)
Resilience	The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation. (GCoM) A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment. (EPA)
Resilience Hub	Resilience Hubs are community-serving facilities augmented to [support] residents and coordinate resource distribution and services before, during, or after a natural hazard event. They leverage established, trusted, and community-managed facilities that are used year-round as neighborhood centers for community-building activities. An existing well-used and well-trusted site is the core of a Resilience Hub. The best sites are those that are in fairly good condition and can support other critical elements such as solar and energy storage systems. (USDN)
Ridesharing/Carpooling	Rideshare programs help people share vehicles and travel together. Ridesharing, also called carpooling, reduces travel costs, traffic, and parking needs. Some local and regional governments provide incentives for ridesharing, such as access to high occupancy vehicle (HOV) lanes. (DOE)
Risk	The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. The term risk is often used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services) and infrastructure. (GCoM)
Riverine Flood	A river flood occurs when water levels rise over the top of riverbanks due to excessive rain from tropical systems making landfall, persistent thunderstorms over the same area for extended periods of time, combined rainfall and snowmelt, or an ice jam. (NOAA)
Severe Thunderstorm	A thunderstorm is a rain shower during which you hear thunder. Since thunder comes from lightning, all thunderstorms have lightning. A thunderstorm is classified as “severe” when it contains one or more of the following: hail one inch or greater, winds gusting in excess of 50 knots (57.5 mph), or a tornado. (NOAA)

Solar Cooperative (Solar Co-op)	Solar Cooperatives are groups of consumers (typically 50-100) who have organized to install solar energy systems together. Coop members leverage bulk-purchasing power to get discounted pricing and a quality installation, while signing individual contracts that ensure the right system for their home/building. (Solar United Neighbors)
Solar-Ready	Solar-ready building design, as the name suggests, refers to designing and constructing a building in a way that facilitates and optimizes the installation of a rooftop solar photovoltaic (PV) system at some point after the building has been constructed. Solar-ready design can make future PV system installation more cost-effective by reducing the need for infrastructure upgrades, ensuring solar technical feasibility, and planning for PV system optimization. (NREL)
Storm Surge	Storm surge is an abnormal rise in water level in coastal areas, over and above the regular astronomical tide, caused by forces [generated] from a severe storm's wind, waves, and low atmospheric pressure. Storm surge is extremely dangerous, because it is capable of flooding large coastal areas. Extreme flooding can occur in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 20 feet or more in some cases. Along the coast, storm surge is often the greatest threat to life and property from a hurricane. In the past, large death tolls have resulted from the rise of the ocean associated with many of the major hurricanes that have made landfall. (NOAA)
Synthetic/Virtual/Financial Power Purchase Agreement (PPA)	Within a Virtual PPA contract, the corporate buyer does not own and is not responsible for the physical electrons generated by the project. The VPPA is purely a financial transaction, exchanging a fixed-price cash flow for a variable-priced cash flow and renewable energy certificates (RECs). Because the VPPA is purely financial, the buyer still needs to meet its electricity load through traditional channels—therefore, the VPPA means the buyer's relationship with its utility at the retail level remains unchanged. (Rocky Mountain Institute) With a Virtual PPA, the energy doesn't physically flow from the project to the buyer. It is merely a financial contract, which is why it's often referred to as a "financial PPA." In a VPPA, the energy is sold on the wholesale electricity market at a defined settlement location (node, trading hub or load zone). The buyer continues to get their electricity from their utility company at their utility's rate. (Level10 Energy)
Underserved Population	"Underserved population" or "traditionally underserved population" refers to a broad category that includes minority and low-income populations but may also include many other demographic categories that face challenges engaging with the transportation process and reaping equitable benefits, such as children, the elderly, and the disabled. (FHWA)

Urban Heat Island	An urban area characterized by temperatures higher than those of the surrounding non-urban area. As urban areas develop, buildings, roads, and other infrastructure replace open land and vegetation. These surfaces absorb more solar energy, which can create higher temperatures in urban areas. (EPA)
Vehicle Miles Traveled (VMT)	Vehicle Miles Traveled (VMT) measures the total annual miles of vehicle travel divided by the total population in a state or urbanized area. The total annual miles are based on individual state reports on traffic data counts collected through permanent automatic traffic recorders on public roadways. (US DOT)
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (GCoM).
Vulnerable Populations	Vulnerable groups are local-context-bound and could include: women and girls, children and youth, the elderly, indigenous population, marginalized groups (due to race, ethnicity, social/political conditions, etc.), persons with disabilities, persons with chronic diseases (e.g., HIV/AIDS, malaria, etc.), low-income households, unemployed persons, persons living in sub-standard housing, etc. These vulnerable groups often experience differential impacts from the same hazard. For example, richer households may have better capacity to cope with flooding, for instance, either through insurance schemes or physical protection of their assets. As such, they would be less affected by the same hazard compared to poor households. Ultimately, the impacts of a hazard depend on specific socioeconomic, political, personal, institutional and environmental conditions that determine the coping and adaptive capacity of the affected population. Vulnerable communities affected by flooding, for example, have different socioeconomic specificities and adaptation deficits compared to the people impacted by extreme hot temperatures. (GCoM)
Waste-to-Energy (WTE) Facility	Municipal solid waste (MSW) is used to produce energy at waste-to-energy (WTE) plants and at landfills. This waste, comprised of biomass materials (e.g. plant or animal products, paper and cardboard) and nonbiomass combustible materials (e.g. plastics and other synthetic materials), is usually burned at special WTE plants that use the heat from the fire to make steam for generating electricity or to heat buildings. (EIA)
Zero Emissions Vehicle (ZEV)	Vehicles which produce no emissions from the on-board source of power (e.g., an electric vehicle). (California Air Resources Board) Zero-emission vehicles (ZEVs), are vehicles that have an electric powertrain that produces zero tailpipe emissions. There are several

	types of ZEVs, including battery electric vehicles (BEVs) that run solely on electricity, plug-in hybrid electric vehicles (PHEVs) that use both electricity and gasoline, and hydrogen fuel cell vehicles (FCVs), which generate electricity from hydrogen. (ZEV Task Force)
Zero Waste	Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. (Zero Waste International Alliance)

APPENDIX C: LIST OF METROPOLITAN WASHINGTON GHG EMISSION REDUCTION PLANS AND GOALS

Regional

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS (COG)

- Metropolitan Washington 2030 Climate and Energy Action Plan, 2020
  - 50 percent below 2005 levels by 2030
  - Carbon neutrality by 2050
- Regional Climate and Energy Action Plans, 2010 – 2020
  - Align with 2008 National Capital Region Climate Change Report
- Region Forward Goals, 2010
  - We seek a significant decrease in greenhouse gas emissions, with substantial reductions from the built environment and transportation sector.
- National Capital Region Climate Change Report, 2008
  - 10 percent below business-as-usual projections by 2012 (back down to 2005 levels)
  - 20 percent below the 2005 levels by 2020
  - 80 percent below 2005 levels by 2050

Commented [MD1]: This assumes the COG Board adopts new GHG emission reduction goals in Oct 2020.

District of Columbia

WASHINGTON D.C. GOVERNMENT

- Sustainable DC 2.0, 2019
  - 50 percent by 2032 below 2006 levels
  - Carbon neutral by 2050
- Clean Energy DC Plan, 2016
  - 50 percent by 2032 below 2006 levels
  - 80 percent by 2050
- Sustainable DC Plan, 2012
  - 50 percent by 2032 below 2006 levels
- DC Climate of Opportunity Report, 2010
  - 20 percent below 2006 levels by 2012
  - 30 percent below 2006 levels by 2020
  - 80 percent below 2006 levels by 2050

Maryland

CITY OF BOWIE

- Updated Climate Action Plan, 2020
  - 50 percent by 2030 below 2015 levels
- Original Climate Action Plan, 2015
  - 20 percent by 2020 below 2007 levels

CITY OF FREDERICK

- Climate Emergency Resolution, 2020

- 50 percent by 2030 below 2010 levels
- 100 percent by 2050

CITY OF GREENBELT

- Sustainability Plan Framework, 2013
  - Meet State of MD and COG goals (COG goals noted above and MD goal of 25 percent below 2006 levels by 2020)

CITY OF ROCKVILLE

- Rockville 2040: Comprehensive Plan Update (DRAFT), 2019
  - Meet mandated Maryland level of 40 percent below 2006 levels by 2030
- Rockville Energy Action Plan, 2013
- Strategy for a Sustainable Rockville, 2007
  - Identifies Rockville as a signatory to the US Mayor's Climate Protection Agreement. It is a commitment to meet or beat Kyoto protocols in their community (e.g. 7 percent below 1990 levels by 2012).

CITY OF TAKOMA PARK

- Climate Emergency Resolution, 2019, and Resolution on 2020 Climate Emergency Response Framework – From Nuclear Free to Fossil Fuel Free to Build a Healthy and Livable Community for All
  - Zero GHG emissions by 2035
- Sustainable Energy Action Plan, 2014
  - Does not establish new GHG goals but instead works towards being consistent with state, County, and COG plans.
- Local Action Plan for Reducing Greenhouse Gas Emissions, 2000
  - Reduce CO_2 emissions in 80 percent below 1990 levels by 2010.

FREDERICK COUNTY

- Climate Emergency Resolution, 2020
  - 50 percent from 2010 levels by 2030
  - 100 percent by 2050
- Sustainable Frederick County, 2017
- Sustainable Action Plan for County Operations, 2011
  - 25 percent reduction by 2025 below 2007 levels

MONTGOMERY COUNTY

- Emergency Climate Mobilization Resolution, 2017, and Climate Mobilization Report, 2018
  - Reduce County GHG emissions to 80 percent below 2005 levels by 2027 and to 100 percent below 2005 levels by 2035.
- Montgomery County Climate Protection Plan, 2009
  - Reduce GHG emissions to 80 percent below 2005 levels by 2050. Stop increasing County wide GHGs by 2010 and achieve 10 percent reduction every 5 years through 2050.

PRINCE GEORGE'S COUNTY

- 80 percent below 2008 levels by 2050

WASHINGTON SUBURBAN SANITARY COMMISSION (WSSC)

- GHG Action Plan, originally adopted in 2012, latest update is 2018
    - 10 percent reduction in emissions every 5 years through 2050, for a total reduction of 80 percent below the baseline year of 2005
    - Adopted these to be consistent with the Montgomery County, Prince George's County and COG goals.

Virginia

ARLINGTON COUNTY

- Community Energy Plan Update, 2019
    - County-wide carbon neutral by 2050
- Community Energy Plan, 2013
    - County-wide > 70 percent below 2007 levels by 2050, down to 3.0 mt CO_2e per capita per year

CITY OF ALEXANDRIA

- Climate Emergency Resolution, 2019
- Eco-City Alexandria Environmental Action Plan, 2019
    - 50 percent below 2005 levels by 2030
    - 80 - 100 percent below 2005 levels by 2050
- Energy and Climate Change Action Plan, 2011
    - By 2012, reduce GHG emissions to 2005 levels;
    - By 2020, reduce GHG emissions by 20 percent below 2005 levels
    - By 2050, reduce GHG emissions by 80 percent below 2005 levels

CITY OF FALLS CHURCH

- Resolution Adopting COG Regional GHG Emission Reduction Goals, 2017

LOUDOUN COUNTY

- Loudoun County Energy Strategy, 2009
    - County-wide goal to reduce GHGs from 3.85 million metric ton to 3.0 million metric ton by 2040
    - Government operations goal to reduce emissions 15 percent between 2007 and 2012

PRINCE WILLIAM COUNTY

- County Energy Plan, 2007, and the Green Guiding Principles, 2009
    - 30 percent by 2025, bringing emissions back to 2000 levels

APPENDIX D: COG MEMBER COLLABORATIVE CLIMATE PROGRAM COMMITMENTS

Region Forward

The Metropolitan Washington Council of Governments' (COG) *Region Forward* Vision focuses on creating a more prosperous, accessible, livable, and sustainable metropolitan Washington. All COG members in 2010 signed onto the *Region Forward* goals by adopting via their local governing body (i.e. city council, county commission). The climate and energy goals include commitments to reducing greenhouse gas (GHG) emissions and the efficient use of energy, with reliance on renewable energy and alternative fuels.

COG MEMBER PARTICIPANTS

- COG
- All COG Member Jurisdictions

Global Covenant of Mayors

The Global Covenant of Mayors for Climate & Energy (GCoM) is the largest global alliance for local climate leadership working toward a resilient and low-emission society. Over 9,000 local governments from 6 continents and 132 countries are signatories. GCoM, formed in 2017, is a merger of the Covenant of Mayors (formed in 2008) and the Compact of Mayors (formed in 2014). Signatory in both initiatives merged into GCoM. GCoM cities are working toward a goal of reducing GHG emissions 40 percent by 2030. Signatories communicate their commitment to citizens, develop citywide knowledge, goals, and plans that aim at least as high as their country's own climate protections commitments to the Paris Climate Agreement, and track and report their progress every two years.

COG MEMBER PARTICIPANTS

- Arlington County
- City of Greenbelt
- City of Takoma Park
- COG
- District of Columbia
- Town of Bladensburg

The Climate Mobilization

The Climate Emergency Campaign encourages governments to adopt an emergency response to climate change with a commitment to reach zero emissions at emergency speed and for elected officials to become emergency Climate Mobilization advocates. The first government to declare a climate emergency was in 2016. There are now more than 860 governments across 18 countries that have declared a climate emergency. The Climate Mobilization is a non-profit that develops and advocates for climate mobilization policies and leads this campaign. Organizer tools, declaration templates and other resources are available.

COG MEMBER PARTICIPANTS

- City of Alexandria
- City of Frederick
- City of Takoma Park
- Frederick County
- Montgomery County

We Are Still In

The We Are Still In pledge is an open letter signed by multiple types of entities, including universities, businesses, non-profits, and governments declaring that signatories will continue to support climate action to meet the Paris Agreement. The group formed in 2017 in the wake of the US announcing it would withdraw from the Paris Agreement. There are no tracking requirements, but signatories can submit information on their climate actions and the organization will connect them to resources and support.

COG MEMBER PARTICIPANTS

- Arlington County
- City of Alexandria
- City of College Park
- City of Fairfax
- City of Falls Church
- City of Gaithersburg
- City of Laurel
- City of Rockville
- City of Takoma Park
- Commonwealth of Virginia
- District of Columbia
- Fairfax County
- Frederick County
- Montgomery County
- Prince George's County

Climate Mayors

The Mayors National Climate Action Agenda, aka Climate Mayors, founded in 2014, is a network of mayors that work together to strengthen local efforts for reducing GHG emissions and support binding federal and global-level policymaking.

There are no binding commitments as a Climate Mayors member, only that cities are pursuing actions to achieve an emissions reduction target through developing a GHG inventory, setting near- and long-term targets to reduce emissions, and developing a Climate Action Plan aligned with the city's targets.

COG MEMBER PARTICIPANTS

- City of Alexandria
- City of College Park
- City of Fairfax
- City of Falls Church

- City of Greenbelt
- City of Hyattsville
- City of Laurel
- City of Takoma Park
- District of Columbia
- Fairfax County

Mayors Climate Protection Agreement

The US Conference of Mayors launched the Mayors Climate Protection Agreement in 2005 after 141 nations ratified the Kyoto Protocol. Participating cities commit to:

- Strive to meet or beat the Kyoto Protocol targets in their own communities.
- Urge their state governments, and the federal government, to enact policies and programs to meet or beat the GHG emission reduction target suggested for the US in the Kyoto Protocol (7 percent reduction from 1990 levels by 2012).
- Urge the US Congress to pass bipartisan GHG reduction legislation, which would create a national emission trading system.

COG MEMBER PARTICIPANTS

- City of Alexandria
- City of Laurel
- City of Gaithersburg
- City of Rockville
- City of Takoma Park
- District of Columbia

C40 Cites

C40 Cities Climate Leadership Group (C40), founded in 2005, is a network of 94 of the world's megacities committed to addressing climate change and achieving the goals of the Paris Agreement. C40 supports cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change.

COG MEMBER PARTICIPANTS

- District of Columbia

Carbon Neutral Cities Alliance

The Carbon Neutral Cities Alliance (CNCA), founded in 2014, is a collaboration of cities working to cut GHG emissions by 80 - 100 percent by 2050 or sooner. Cities must meet the following criteria:

- City Council formally adopted community-wide carbon neutrality goal across all sectors.
- Developed, or is currently developing, community-wide carbon neutrality implementation plan.
- Dedicated budget and staff allocated to implementing its carbon neutrality plan.
- City is committed to active participation in the Alliiance.

COG MEMBER PARTICIPANTS

- District of Columbia

Ready for 100 Campaign

The Sierra Club's Ready for 100 campaign, launched in 2016, is a national movement of people working to inspire our leaders to embrace 100 percent clean, renewable energy. Commitments often start with a statement or proclamation in support of 100 percent renewable energy that moves to a binding commitment, but communities can commit through a variety of pathways.

COG MEMBER PARTICIPANTS

- Arlington County
- City of Alexandria

Net Zero Carbon Buildings Commitment

The Net Zero Carbon Buildings Commitment challenges companies, cities, states and regions to reach Net Zero operating emissions in their portfolios by 2030, and to advocate for all buildings to be Net Zero in operation by 2050. This Commitment initiative launched in 2018 to help ensure delivery of the highest ambitions of the Paris Agreement. Signatories commit to the goals, annually measuring and disclosing asset and portfolio energy demand and carbon emissions, developing and implementing a carbon roadmap, demonstrate progress and advocate for the transition to net zero carbon buildings. Partner organizations include the World Green Building Council, C40 Cities, and Under2 Coalition.

COG MEMBER PARTICIPANTS

- Arlington County
- District of Columbia

Under2 Coalition

The Under2 Coalition, founded in 2015, is a group of ambitious city, state, and regional governments representing 1.3 billion people and 43 percent of the global economy that are committed to deep decarbonization pathway planning, scaling innovative policy solutions, and transparency to keep the global temperature rise to well below 2 degrees Celsius. Under2 Coalition promotes capacity building and peer learning amongst members, encourages members to disclose annually to CDP, and provides members guidance resources.

COG MEMBER PARTICIPANTS

- Commonwealth of Virginia
- Montgomery County
- State of Maryland

United States Climate Alliance

The United States Climate Alliance is a bipartisan coalition of 24 governors committed to reducing GHGs consistent with the goals of the Paris Agreement. The Alliance launched in 2017 in response to the US decision to withdraw from the Paris Agreement. Member states commit to:

- Implement policies that advance the goals of the Paris Agreement, aiming to reduce greenhouse gas emissions by at least 26 - 28 percent below 2005 levels by 2025.
- Track and report progress to the global community in appropriate settings, including when the world convenes to take stock of the Paris Agreement.
- Accelerate new and existing policies to reduce carbon pollution and promote clean energy deployment at the state and federal level.

COG MEMBER PARTICIPANTS

- Commonwealth of Virginia
- State of Maryland

Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI), established in 2009, is the first mandatory market-based program in the US to reduce GHGs. RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce CO_2 emissions from the power sector.

COG MEMBER PARTICIPANTS

- Commonwealth of Virginia
- State of Maryland

Transportation and Climate Initiative

The Transportation and Climate Initiative (TCI), launched in 2010 and modeled after RGGI, is a regional collaboration of 12 Northeast and Mid-Atlantic states and the District of Columbia that are committed to improve transportation, develop the clean energy economy, and reduce carbon emissions from the transportation sector.

COG MEMBER PARTICIPANTS

- Commonwealth of Virginia
- District of Columbia
- State of Maryland

METREX Agreement

The METREX Agreement, established in 2008, is an agreement to cooperate on building knowledge to advance climate change policies between US and European regions. Signatories include the Network of European Metropolitan Regions and Areas, the National Association of Regional Councils, the Northern Virginia Regional Commission (NVRC), and COG.

COG MEMBER PARTICIPANTS

- COG
- Northern Virginia Regional Commission

LEED for Cities and Communities

The LEED for Cities and Communities programs, established in 2018, provide cities and communities with a globally consistent way to measure and communicate performance. Localities achieving LEED designation develop responsible, sustainable, and specific plans for natural systems, energy, water, waste, transportation and other factors that contribute to quality of life.

COG MEMBER PARTICIPANTS

- Arlington County
- City of Frederick
- District of Columbia
- Frederick County
- Montgomery County

Sustainable Maryland

Established in 2011, Sustainable Maryland is a certification program for municipalities that want to go green, save money and take steps to sustain their quality of life over the long term. There are currently 75 Maryland communities participating, 35 of which are currently certified. The program offers guidance, trainings, and technical support. Sustainable Maryland is a collaborative program of the Environmental Finance Center at the University of Maryland and the Maryland Municipal League.

COG MEMBER PARTICIPANTS

- City of Bowie
- City of College Park
- City of Frederick
- City of Gaithersburg
- City of Greenbelt
- City of Hyattsville
- City of Laurel
- City of Rockville
- City of Takoma Park
- Town of Bladensburg

Go Green Virginia

The Go Green Virginia initiative (Go Green VA) recognizes that communities need to take innovative steps to reduce energy usage and promote sustainability. Most importantly, local governments are urged to participate in a friendly competition - the Green Government Challenge. The "Challenge" is designed to encourage implementation of environmental policies and practical actions that reduce carbon emissions and can save local governments money. Go Green VA is a program of the Virginia Municipal League, the Virginia Association of Counties, and the Virginia School Board Association.

COG MEMBER PARTICIPANTS

- Arlington County
- City of Alexandria
- City of Falls Church
- Loudoun County
- Prince William County

APPENDIX E: LIST OF STATE LEGISLATION SUPPORTING GHG EMISSION REDUCTION IN METROPOLITAN WASHINGTON

DISTRICT OF COLUMBIA

GREEN BUILDING REGULATIONS, 2006, 2013

- The 2006 Green Building Act established high performance building standards for public and private projects.
- The 2013 DC Construction Codes include the adoption of the 2012 International Green Construction Codes and the 2012 International Energy Construction Codes.

CLEAN AND AFFORDABLE ENERGY ACT, 2008

- Established DC Sustainable Energy Utility (SEU) to administer sustainable energy programs in the District of Columbia.
- Energy efficiency measures are amended in 2018 CleanEnergy Act

CLEAN CARS ACT, 2008

- Adopted California's Clean Cars Program LEV II emission standards, with phase-in beginning in 2012. Provides a 90 percent reduction in harmful vehicle emissions.
- The Clean Cars Program represented the first program that directly regulates carbon dioxide (CO) emissions.

SUSTAINABLE DC ACT, 2012, 2014

- Sustainable DC Act of 2012 consisted of nine components with sustainability measures, and all nine proposals were adopted by the District Council.
- Sustainable DC Omnibus Amendment Act of 2014
    - Supports the District building a benchmarking program by making data on energy and water use more accessible.
    - Creates an environmental literacy program.
    - Prohibits the sale or use of polystyrene containers for food service.
    - Requires payment to offset the destruction or removal of a tree.

CLEANENERGY DC OMNIBUS AMENDMENT ACT, 2018

- Increases the District's RPS to 100 percent by 2032.
- Establishes a solar energy standard beyond 2032 (5 percent solar by 2032, and 10 percent by 2041).
- Removes restrictions on types of energy efficiency measures that the SEU must offer.
- Expands the uses of the Sustainable Energy Trust Fund.
- Establishes building energy performance standard program at DOEE. Expands DOEE's benchmarking program to include buildings of 10,000 square feet of more by 2024.
- Establishes an energy efficiency program.
- Requires the DMV to issue regulations tying the vehicle excise tax to fuel efficiency.
- Establishes a transportation electrification program. By 2045, all public transportation and privately-owned vehicle fleets in DC will have to be zero emission vehicles.

- Authorizes the Mayor to commit the District to participation in regional GHG reduction programs.

MARYLAND

MARYLAND JOINED REGIONAL GREENHOUSE GAS INITIATIVE (RGGI), 2007

- Establishes a regional cap on the amount of CO_2 pollution that power plants can emit by issuing a limited number of tradable CO_2 allowances. Each allowance represents an authorization for a regulated power plant to emit one short ton of CO_2. Individual CO_2 budget trading programs in each RGGI state together create a regional market for CO_2 allowances.

MARYLAND CLEAN CARS ACT, 2007

- Adopted California's Clean Cars Program LEV II emission standards, with phase-in beginning in 2011. Provides a 90 percent reduction in harmful vehicle emissions.
- The Clean Cars Program represented the first program that directly regulates carbon dioxide (CO) emissions.

MARYLAND GREEN BUILDING REGULATIONS, 2008, 2014, 2017

- The High Performance Building Act passed in 2008 and green building requirements were updated in 2017.
- Maryland adopted the 2012 International Green Construction Code (IgCC) in 2014.
- All new or significantly renovated fully State funded buildings, K thru 12 public schools and new community college buildings over 7,500 gross square feet shall be constructed as High Performance Buildings (at least to LEED Silver certification).

EMPOWER MARYLAND ENERGY EFFICIENCY ACT, 2008

- Established a goal to reduce per capita electricity usage and peak demand 15 percent by 2015.
- For 2016 and beyond, the Public Service Commission will continue to require utilities to establish any program that it deems appropriate and cost effective to encourage and promote the efficient use and conservation of energy.
- The Commission has established a new goal structure, which requires electric utilities to achieve annual incremental cost-effective energy savings equal to two percent of their retail electric sales.

GREENHOUSE GAS REDUCTION ACT (GGRA), 2009, 2016

- Requires a 25 percent reduction of GHG emissions from 2006 levels by 2020.
- Required the creation of Maryland's Greenhouse Gas Reduction Plan.
- In 2016, goal was further extended to a 40 percent reduction from 2006 levels by 2030.

CLEAN ENERGY JOBS ACT, 2018

- Increases the State's Renewable Portfolio Standard (RPS) to 50 percent by 2030. Evaluates steps to reaching 100 percent clean energy by 2040.
- The 50 percent RPS will include 14.5 percent solar and at least 1,200 MW of offshore wind by 2030. Remaining portion comes from "Tier 1" renewable resources (waste-to-energy is still included in this).
- Original RPS of 2004 was 20 percent by 2022.

MARYLAND ENERGY CONSERVATION CODE, 2019

- Adopted the 2018 International Energy Conservation Code with amendments.

VIRGINIA

VIRGINIA ENERGY CONSERVATION CODE, 2018

- Adopted the 2015 International Energy Conservation Code with amendments.

GRID TRANSFORMATION AND SECURITY ACT, 2018

- Increases capacity of solar and wind generation facilities constructed by a utility that are in the public interest from 50 MW to 5,000 MW.
- Requires Dominion Energy to develop programs of energy conservation measures. Dominion Energy's program costing not less than $870 million.
- Directs the SCC to conduct pilot programs for the deployment of electric power storage batteries with capacity limits of up to 10 MW for Appalachian Power and 30 MW for Dominion Energy.

VIRGINIA CARBON RULE, 2019

- Reduces and caps carbon dioxide emissions from large fossil fuel fired electric power generating facilities 30 percent by 2030.

CLEAN ECONOMY ACT, 2020

- Establishes a mandatory RPS with the goal of 100 percent clean electricity by 2050.
    - 100 percent for Phase I Utilities (investor-owned utilities that were, as of July 1, 1999, not bound by a rate case settlement adopted by the State Corporation Commission (SCC) that extended in their application beyond January 1, 2002) by 2045
    - 100 percent for Phase II Utilities (investor-owned utilities that were bound by such settlements highlighted above) by 2050
- Dominion Energy and Appalachian Power (APCo) need to retire their carbon-emitting electrical generation facilities. The dates by which they need to do so depends on the type of plant and the size of the facility.
- The net metering cap for residential customers will increase from 20 kW to 25 kW; residential Dominion customers can also size their system to meet up to 150 percent of their annual electricity demand.
- It requires Dominion to build 16,100 MW of onshore wind and solar energy, and APCo to build 600 MW. The law also contains one of the strongest energy storage mandates in the country: 2,700 MW for Dominion, 400 MW for APCo.
- There are new energy efficiency standards for utilities, including programs to support low-income populations.
- The RPS includes a solar carve-out for Dominion, mandating that at least 1 percent of its renewable energy generation must come from distributed solar panel systems less than 1 MW large.
- Original voluntary RPS of 2007 was 15 percent of sales by 2025.

CLEAN ENERGY AND COMMUNITY FLOOD PREPAREDNESS ACT, 2020

- Allows the Department of Environmental Quality (DEQ) to establish, implement, and manage an auction program to sell allowances into a market-based trading program (i.e. RGGI).
- The Department of Housing and Community Development will spend 50 percent of auction proceeds on low-income energy efficiency programs, including programs for eligible housing developments.
- The Department of Conservation and Recreation will get 45 percent of the auction proceeds to fund flood preparedness and climate change planning and mitigation through the Virginia Community Flood Preparedness Fund.
- The last 5 percent of proceeds will cover administrative costs, including those for administering the auctions.

SOLAR FREEDOM ACT, 2020

- Requires the SCC to establish by regulation a shared solar program that allows multifamily customers of investor-owned utilities, other than American Electric Power, to purchase electric power through a subscription in a shared solar facility.
- Raises the cap on the total amount of renewable energy that can be net metered in a utility's service territory from 1 percent to 6 percent, 5 percent of which is available to all customers and 1 percent of which is available only to low-income utility customers.
- Raises the cap for net-metered non-residential generation facilities from 1 MW to 3 MW.
- Allows certain localities to install solar or wind facilities of up to 5 MW on government-owned property and use the electricity for government-owned buildings.
- Increases the cap on the capacity of generation from facilities from the customer's expected annual energy consumption to 150 percent of such amount for customers in Dominion Energy's service territory.
- Prohibits standby charges for any residential customer-generator or agricultural customer-generator of an investor-owned utility other than Dominion Energy.
- Increases the cap on third party PPAs to 500 MW for jurisdictional customers and 500 MW for non-jurisdictional customers of Dominion Energy and to 40 MW for customers of American Electric Power. The measure also amends the Commonwealth Energy Policy to include provisions supporting distributed generation of renewable energy.

APPENDIX F: GHG INVENTORY METHODOLOGY

INTRODUCTION

Purpose

This appendix outlines the methodologies of COG's greenhouse gas (GHG) inventory work, providing for completeness, consistency, accuracy, replicability, transparency, and quality control. The ability to develop relevant, robust sets of inventories supports COG's Climate, Energy and Environment Policy Committee (CEEPC) and member local governments track progress towards GHG emission reduction goals and support decision-making around policies and programs that support emission reduction.

Background

COG's Climate, Energy and Environment Policy Committee (CEEPC) was created by the COG Board in 2009 and is responsible for managing implementation of the *National Capital Region Climate Change Report* adopted by the COG Board in 2008. Since its inception, CEEPC has made it a priority to track progress towards emissions reduction and set goals for all COG members and the region to complete GHG inventories.

Over the next five years, COG supported its members on inventory development by coordinating GHG inventory work group meetings and a series of trainings with national experts from ICLEI. COG also participated in development of a national protocol for local community-scale inventories, provided consultant support for COG member local inventory development, and began working on applying consistent methodologies across jurisdictions.

Members of both CEEPC and its sub-committees requested additional support to ensure 100 percent of COG members were able to have consistent, comparable GHG inventories completed and have updates on their inventories completed to track progress towards GHG emission reduction goals. COG has completed local and regional GHG inventories for all COG members and metropolitan Washington for 2005, 2012, 2015, and 2018.

Methodology Basics

COG completes GHG community-scale inventories for all 24 local government members and metropolitan Washington. COG makes every effort to capture an accurate picture of GHG trends for each of its local government members, while also providing for a consistently applied methodology across all its members' communities. Local inventory results are added together to get the total regional GHG emissions.

COG GHG inventories strive to be compliant with both the U.S. Communities Protocol for Accounting and Reporting Greenhouse Gas Emissions (USCP) and Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC). The Protocols provide guidance on what emission types should at minimum be included in all local community GHG inventories. Additional guidance on approaches to calculating emissions are offered, but not prescribed. COG mainly follows the calculation guidance from USCP as the USCP identifies sources of data widely available to communities in the US. If COG has reliable local data available that could provide more accurate results then an alternative approach, calculation, or tool is used.

COG inventories use public data readily-available on a consistent basis for all its local government members. Data sources used must be available for past, current, and potential future inventories to

accurately capture trends. While both accuracy and consistency are important to GHG inventories, consistency will be given a higher priority. Any models used are applied as consistently as possible. If a new version of the model is used, it must be noted. Consistent Global Warming Potential Factors (GWP) are applied; COG inventories use GWP Factors from the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4).

COG inventories follow an activities-based approach, meaning emissions are calculated based on the result of an activity happening in a community. An example of this is that solid waste emissions are calculated based on the tonnage of trash the community sends to a landfill. Simply because they do not have a landfill within their jurisdiction's boundaries, does not mean that they are not contributing to landfill emissions. This approach accounts for these types of activities for the emissions types reported.

The broad categories of emission types covered by COG's GHG inventory work include the built environment, transportation and mobile emissions, wastewater treatment, agriculture, solid waste treatment, and some process and fugitive emissions. Most of these are required elements to be compliant with the USCP and GPC. Neither require agriculture; however, it was requested for inclusion by COG member counties (Appendix Table 1).

Appendix Table 1: Emission Types in COG Inventories Compared to Protocol Requirements

Emissions Types	COG Inventory?	USCP Required?	GPC Required?
Built Environment	√	√	√
Transportation and Mobile	√	√	√
Wastewater Treatment	√	√	√
Agriculture	√	X	X
Solid Waste Treatment	√	√	√
Some Process and Fugitive	√	X	√

These emission types are further broken down into 16 emissions activities and 22 separate inventory records that are calculated and added together to get total emissions by type and overall emissions. The gases calculated within these inventory records include carbon dioxide (CO2), methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), and Perfluorocarbons (PFCs).

Appendix Table 2 is a detailed table of the emission types, activities calculated, GHGs and methodologies covered, and data confidence levels.

Appendix Table 2: Methodology Summary Table

Emissions Type	Emissions Activity or Source	GHG Types (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6)	Methodology (From US Communities Protocol, v 1.1)	Data Quality Confidence Levels (High, Medium, Low)
BUILT ENVIRONMENT				
Residential Energy	Emissions from Grid Electricity *	CO_2, CH_4, N_2O	Appendix C, BE.2.1	High
	Emissions from Stationary Fuel (Natural Gas) *		Appendix C, BE.1.1	High
	Emissions from Stationary Fuel (Fuel Oil, LPG) *		Appendix C, BE.1.2	Medium
Commercial and Industrial Energy	Emissions from Grid Electricity *	CO_2, CH_4, N_2O	Appendix C, BE.2.1	High
	Emissions from Stationary Fuel (Natural Gas) *		Appendix C, BE.1.1	High
	Emissions from Stationary Fuel (Fuel Oil, LPG) *		Appendix C, BE.1.3	Medium
	Industrial Point Source Emissions from Stationary Fuel Combustion	Any GHG	IE in commercial and industrial stational fuel and solid waste	N/A
	Consumption of District Energy	CO_2, CH_4, N_2O	IE in commercial and industrial grid electricity and stational fuel	N/A
TRANSPORTATION AND MOBILE EMISSIONS				
Transportation and Mobile Emissions	On Road Transportation *	CO_2, CH_4, N_2O	Appendix D, TR.1.A	High
	Emissions from Public Transit *		IE in On Road	N/A
	Aviation Travel		Appendix D, TR.6.D	Medium
	Rail Transportation *		Appendix D, TR.4	Medium
	Emissions from Off Road Vehicles *		Appendix D, TR.8	High
	Water Transportation *		IE in Non-Road	N/A
WASTEWATER TREATMENT				
Water and Wastewater	Emissions from Wastewater Treatment Energy Use *	CO_2, CH_4, and N_2O from electricity and fuels	IE in commercial and industrial energy	N/A
	Emissions from the Supply of Potable Water *	CO_2, CH_4, and N_2O from electricity and fuels	IE in commercial and industrial energy	N/A
	Fugitive Emissions from Septic Systems*	Fugitive CH_4	Appendix F, WW.11	High
	Nitrification/Denitrification Process N2O Emissions from Wastewater Treatment *	Process N_2O	Appendix F, WW.7	High
	Process N2O from Effluent Discharge to Rivers and Estuaries *	Fugitive N_2O	Appendix F, WW.12	High
AGRICULTURE				
Agriculture	Emissions from Agricultural Activities	CH_4, N_2O	Alternate Method - EPA State Inventory Tool, AG Module	Medium
	Emissions from Stationary Fuel Combustion	CO_2, CH_4, N_2O	IE in commercial and industrial grid electricity and stational fuel	N/A
	Emissions from Grid Electricity			
SOLID WASTE TREATMENT				
Solid Waste	Waste Generation (Landfill) *	Fugitive CH_4	Appendix E, SW.4	Medium
	Process Emissions Associated with Landfilling	CO_2e	NE	N/A
	Combustion of Solid Waste Generated by the Community *	Fossil CO_2, N_2O, CH_4 (biologic CO_2 optional)	Appendix E, SW.2.2	Medium
	Biologic Treatment of Solid Waste (Composting)	CO_2, CH_4, N_2O	NE	N/A

OTHER				
Process and Fugitive Emissions	Other Process and Fugitive	HFCs, PFCs, Refridgerant Blends	Alternate Method - Downscale from national inventory	Medium
	Fugitive Emissions from Oil Systems, Mining, Processing, Storage, and Transportation of Coal	CO_2, CH_4, N_2O	NE	N/A
	Fugitive Emissions from Natural Gas Distribution	CO_2, CH_4	ClearPath calculator	High
Upstream Impacts of Activities	Upstream Impacts of Electricity Used by the Community	CO_2, CH_4, N_2O	NE	N/A
	Upstream Impacts of Fuels Used in Stationary Combustion by the Community			
	Emissions from Electric Power Transmission and Distribution Losses			
Consumption Based	Consumption Based Emissions, Previously Calculated	Any GHG	NE	N/A

Column Header	Description
Emissions Type	This column lists the main tabs in the online ClearPath tool's GHG inventory entry pages in the same order listed in ClearPath.
Emissions Activity/Source	This column lists the ClearPath calculators that are used to calculate or record emissions from activities/sources. * Indicates that reporting for this activity or source is required by the U.S. Community Protocol or Global Protocol for Communitiy-Scale GHG Inventories (BASIC). Those without a * are not requirements of the protocols.
GHG Types	Summarizes the leading GHG emission types that result from each activity or source, including carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
Methodology	The methodologies and calculations generally follow ICLEI's US Community Protocol for Accounting and Reporting GHG Emissions Version 1.1. Modified approaches to the ICLEI methodology are used based on data availability. In addition, notations are made in accordance with the Notation Keys legend below.

Notation Keys	Description
IE = Included Elsewhere	Emissions for this activity are estimated and presented in another category of the inventory. The category where these emissions are included should be noted in explanation.
NE = Not Estimated	Emissions occur but have not been estimated or reported (e.g., data unavailable, effort required not justifiable).
NA = Not Applicable	The activity occurs but does not cause emissions; explanation should be provided.
NO = Not Occurring	The source or activity does not occur or exist within the community.

Note: These notations were developed by the Global Communities Protocol and are also used by the U.S. Communities Protocol. See Version 1.1, 2012, Appendix B.

Process

STAKEHOLDER ENGAGEMENT

COG needs to continue to work with its local government members to capture as accurate of a picture as possible for each community while providing consistent data inputs and methodologies across all communities. In order to accomplish this, COG staff needs to help members understand the existing process and methodologies, provide opportunities for their input on methodologies and the products, and support them on how they want to communicate results to their communities. The local government stakeholder engagement process includes the following:

1. Make COG members aware of the inventory procedure at the beginning of the process and listen to and address any questions/comments/concerns. Discuss any new priorities that need to be considered, potential methodology refinements, etc. from COG members.
2. Present draft results to each community. Address questions/comments/concerns. Revise as needed.
3. Offer and provide one-on-one meetings, as needed, to COG local government members.
4. Provide final products to each community.
5. Support local governments, as needed, in how to communicate results to their communities.

CLEARPATH

ICLEI's ClearPath tool is an online tool for preparing local GHG inventories, forecasts, climate action plans, and monitoring reports. The tool is consistent with both US and global accounting protocols. COG uses the Community Scale Inventory Module to support completing its GHG inventory work for its members and the region.

COG created inventory records in ClearPath for all emission activities in the inventory for Fairfax County. Some of the tool's calculators are used to calculate emissions as inventory records are created, while in other instances, previously calculated emissions are recorded in the inventory record.

METHODOLOGY UPDATES

The practice of developing community-scale inventories is relatively new and has evolved rapidly in recent years. The practice will continue to evolve to provide for more accurate, measured results (rather than modeled). Therefore, the methodologies used in COG inventory work should continue to evolve overtime to incorporate the best available data and methods.

Some methodology updates, like a change in Global Warming Potential Factors, will affect all emission calculations in the inventory. However, more often it may be refinements to the calculations for a specific activity or source. Methodology updates should be prioritized first by how much of an impact they have on the overall inventory. Priority should be given to an activity that accounts for a larger percent of the inventory. Secondly, methodology update needs should be based on current data quality confidence levels. Activities or sources with low-to-medium data quality confidence levels could be investigated to see if more accurate data or calculations methods could be applied.

If methodology changes to how an activity/source is calculated results in more than a 1-2 percent difference, if possible, COG will back cast to change the methodologies from previous years. If methodology changes result in less than a 1-2 percent difference, back casting is not typical nor is it called for by the Protocols. All changes in methodologies between inventory years need to be noted.

To ensure methodology changes are Protocol compliant, COG refers to the USCP and GPC methodologies for guidance throughout the process and requests review of methodology updates by ICLEI, COG members, and other GHG inventory experts.

Getting Started

Setting Up The GHG Inventory

DESCRIPTION

Gathering demographic and economic data is the first step taken in developing the inventories. Some of the demographic and economic data is used to estimate GHG emissions. For instance, household and commercial building data is used to estimate non-utility fuel consumption, such as fuel oil. Also, population data may serve as a means to downscale to a local community when local data is unavailable.

The demographic and economic data are also used as a benchmark throughout the inventory to gauge emissions per person, household, employee, etc. Therefore, it is important to gather this information at the start of the inventory process and use it as consistently as possible across all emissions activity calculations.

DATA COLLECTION

American Community Survey (ACS) has data readily available for all COG member local governments. This data is used as much as possible for calculations and benchmarks throughout the inventory. However, COG transportation and wastewater models use COG Cooperative Forecast data; therefore, transportation on-road and off-road and all wastewater calculations use the Cooperative Forecast data for its benchmarking.

In addition, COG uses CoStar, a commercial building database, to track commercial construction in the region. It also provides readily available data for the GHG inventories. Gross Domestic Product data is an input to provide during the creation of an inventory in ClearPath.

BUILT ENVIRONMENT

Residential Energy

EMISSIONS FROM GRID ELECTRICITY

Residential Electricity

DESCRIPTION

Residential Electricity accounts for emissions resulting in electricity use in residential buildings. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Residential Electricity emission calculations follow the USCP recommended methodology as outlined in Appendix C, BE.2.1 from Version 1.1 of the Protocol.

DATA COLLECTION

COG annually collects aggregated account and consumption data from the 7 electric utilities that serve metropolitan Washington.

Data Needs:

- Accounts: Number of residential electric accounts from all utilities serving metropolitan Washington.
- Consumption: Annual residential electricity use in kilowatt hours from all utilities serving metropolitan Washington.
- eGRID: U.S. Environmental Protection Agency (EPA) eGRID Subregion Output Emission Rates – Greenhouse Gases. Subregions RFC East (RFCE) and SERV Virginia/Carolina (SRVC) total output emission rates of CO_2 (lb/MWh), CH_4 (lb/GWh), and N_2O (lb/GWh).

EMISSIONS FROM STATIONARY FUEL

Residential Natural Gas

DESCRIPTION

Residential Natural Gas consumption accounts for combustion emissions from stationary fuel applications, such as furnaces. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Residential Natural Gas emission calculations generally follow the USCP recommended methodology as outlined in Appendix C, BE.1.1 from Version 1.1 of the Protocol.

DATA COLLECTION

COG annually collects aggregated account and consumption data from the 3 natural gas utilities that serve metropolitan Washington.

Data Needs:

- Accounts: Number of residential natural gas accounts from all utilities serving metropolitan Washington.
- Consumption: Annual residential consumption of natural gas in Therms from all utilities serving metropolitan Washington.

Residential Fuel Oil

DESCRIPTION

Residential Fuel Oil accounts for both distillate fuel oils and kerosene used in stationary applications. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

Distillate fuel oils include both fuel oils and diesel fuels that are further classified by level of volatility, listed from least to greatest (No. 1, No. 2, and No. 4). Residential fuel oils are less volatile than gasoline and are burned for space heating or water heating by private household consumers. No.2 fuel oil (Heating Oil) is the most common type used by households for the specific purpose of heating their home, water heating, cooking, etc., excluding farmhouses, farming, and apartment buildings. No. 1 fuel oil is used by households mainly for portable outdoor stoves and portable outdoor heaters.

Kerosene is a distilled product of oil or coal with the generic name kerosene, having properties like those of No. 1 fuel oil.

METHODOLOGY

The Residential Fuel Oil emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.2 from Version 1.1 of the Protocol. This methodology estimates residential fuel oil consumption in gallons (including distillate fuel oil and kerosene) by estimating per household consumption in DC, MD and VA and multiplying that by the estimated number of households using fuel oil as a home heating fuel in the region and each jurisdiction. Gallons are used to estimate emissions.

DATA COLLECTION

Local data on households and consumption related to fuel oil is not readily available for all COG members. However, the Energy Information Administration (EIA) has readily available data on state-wide fuel oil consumption and the ACS has readily available data on number of households using fuel oil as a home heating fuel.

Data Needs:

- Households using Fuel Oil: Number of households using fuel oil data for all COG jurisdictions and states collected from the ACS' Selected Housing Characteristics.
- Statewide Residential Fuel Oil Consumption: EIA State Energy Data System (SEDs) data for Statewide Residential Distillate Fuel Oil and Kerosene consumption in thousands of barrels (000' Barrels).

Residential LPG

DESCRIPTION

Liquefied Petroleum Gas (LPG) refers to a group of hydrocarbon gases derived from crude oil refining or natural gas processing. Propane is the most common LPG. In the U.S. and Canada, commercially available propane (LPG) is not totally pure; its typically at least 90 percent propane, with the rest being ethane, propylene, butane, and odorants including ethyl mercaptan. LPGs are used as fuel in heating appliances, cooking equipment, and vehicles. It is usually delivered by tank trucks and stored near a housing unit in a tank or cylinder until used; however, propane stored in canisters can also be purchased from retail stores. For our purposes, LPG's are equated with propane, yet propane also encompasses similar fuel gases, such as butane, supplied to a residence in liquid form. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Residential LPG emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.2 from Version 1.1 of the Protocol. This methodology estimates residential LPG consumption in gallons by estimating per household consumption in DC, MD and VA and multiplying that by the estimated number of households using fuel oil as a home heating fuel in the region and each jurisdiction. Gallons are used to estimate emissions.

DATA COLLECTION

Local data on households and consumption related to fuel oil is not readily available for all COG members. However, the EIA has readily available data on state-wide fuel oil consumption and the ACS has readily available data on number of households using fuel oil as a home heating fuel.

Data Needs:

- Households using LPG: Number of households using LPG data for all COG jurisdictions and states collected from the ACS's Selected Housing Characteristics.
- Statewide Residential LPG Consumption: EIA State Energy Data System (SEDs) data for Statewide Residential LPG consumption in thousands of barrels (000' Barrels).

Commercial Energy

EMISSIONS FROM GRID ELECTRICITY

Commercial Electricity

DESCRIPTION

Commercial Electricity accounts for emissions resulting in electricity use in commercial, government, industrial, and other non-residential buildings and facilities. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Commercial Electricity emission calculations follow the USCP recommended methodology as outlined in Appendix C, BE.2.1 from Version 1.1 of the Protocol. Consumption data and the U.S. EPA eGRID emission data are factored into the emission estimates calculated in ClearPath.

DATA COLLECTION

COG annually collects aggregated account and consumption data from the 7 electric utilities that serve metropolitan Washington.

Data Needs:

- Accounts: Number of commercial electric accounts from all utilities serving metropolitan Washington.
- Consumption: Annual commercial electricity consumption in kilowatt hours from all utilities serving metropolitan Washington.
- eGRID: U.S. Environmental Protection Agency (EPA) eGRID Subregion Output Emission Rates – Greenhouse Gases. Subregions RFC East (RFCE) and SERV Virginia/Carolina (SRVC) total output emission rates of CO_2 (lb/MWh), CH_4 (lb/GWh), and N2O (lb/GWh).

EMISSIONS FROM STATIONARY FUEL

Commercial Natural Gas

DESCRIPTION

Natural gas consumption in the non-residential setting produces combustion emissions from stationary applications, such as boilers and furnaces. Energy use in buildings account for a significant portion of GHG emissions. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Commercial natural gas emission calculations generally follow the USCP recommended methodology as outlined in Appendix C, BE.1.1 from Version 1.1 of the Protocol.

DATA COLLECTION

COG annually collects aggregated account and consumption data from the 3 natural utilities that serve metropolitan Washington.

Data Needs:

- Accounts: Number of commercial natural gas accounts from all utilities serving metropolitan Washington.
- Consumption: Annual commercial consumption of natural gas in Therms from all utilities serving metropolitan Washington.

Commercial Fuel Oil

DESCRIPTION

Commercial Fuel Oil refers to a liquid petroleum product used as an energy source that is less volatile than gasoline. Commercial Fuel Oil is comprised of distillate fuels (No. 1, 2 and 4), residual fuels (No.5 and 6) and kerosene (No. 1). Distillate fuel oils represent the lighter petroleum fractions produced in conventional distillation processes that include both fuel oils and diesel fuels that are further classified by level of volatility, listed from least to greatest (No. 1, No. 2, and No. 4). Products known as No. 1, No. 2, and No. 4 fuel oils are lighter oils primarily used for space heating and electric power generation. Residual fuels are generally classified as heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. Kerosene is a light petroleum distillate with properties like those of No. 1 fuel oil; primarily used in space heaters, cook stoves, and water heaters and is suitable for use as a light source when burned in wick-fed lamps. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

The Commercial Fuel Oil emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.3 from Version 1.1 of the Protocol, with one exception. This methodology calculates percent of square footage using fuel oil instead of percent of number of buildings using fuel oil.

Values for commercial building square footage using Fuel Oil were scaled locally by multiplying the local jurisdictional commercial square footage by the percentage of commercial building square footage using Fuel Oil in the broader South Atlantic Region. These values, in turn, were multiplied by the fuel energy intensity in gallons per square foot (gallons/ft.^{2}) to get total Fuel Oil consumption per locality and region. Consumption was converted to emissions in ClearPath.

DATA COLLECTION

The number of commercial buildings and total square footage for each COG member jurisdiction is readily available from the 2015 CoStar Commercial Property Records. There is not data readily available on stationary fuel use for these buildings. The Energy Information Administration (EIA) does have data available for larger regions on total commercial buildings and square footage; number and square footage of buildings using Fuel Oil; and energy intensity. EIA's South Atlantic Region in the Commercial Building Energy Consumption Survey (CBECS) includes DC, MD, VA, DE, WV, NC, SC, GA, and FL.

Data Needs:

- Commercial buildings and total square footage: Data for all COG jurisdictions and region are collected from the CoStar Commercial Property Records. This database is available via subscription by COG's Department of Community Planning and Services Department (CPS).
- Total Commercial Floorspace and Commercial Square Footage using Fuel Oil: Values for the South Atlantic Region (most specific region) were derived from the EIA CBECS.
- Fuel Oil Energy Intensity: A value for the South Atlantic Region was derived directly from the EIA CBECS.

Commercial LPG

DESCRIPTION

Liquefied Petroleum Gas (LPG) refers to a group of hydrocarbon gases derived from crude oil refining processing. Propane is the most common LPG. In the U.S. and Canada, commercially available propane (LPG) is not totally pure; its typically at least 90 percent propane, with the rest being ethane, propylene, butane, and odorants including ethyl mercaptan. According to the USCP, local jurisdictions can often influence energy use through building codes, incentives, and technical assistance.

METHODOLOGY

In this methodology, any LPG reported was assumed to be propane. The Commercial LPG emission calculations follows the USCP recommended methodology as outlined in Appendix C, BE.1.3 from Version 1.1 of the Protocol. This methodology calculates percent of square footage using fuel oil instead of percent of buildings using fuel oil.

Values for commercial building square footage using LPG were scaled locally by multiplying the local jurisdictional commercial square footage by the percentage of commercial building square footage using LPG in the broader South Atlantic Region. These values, in turn, were multiplied by the fuel energy intensity in gallons per square foot (gallons/ft.^{2}) to get total LPG consumption per locality and region. Consumption was converted to emissions in ClearPath.

DATA COLLECTION

The number of commercial buildings and total square footage for each COG member jurisdiction is readily available from the 2015 CoStar Commercial Property Records. There is not data readily available on stationary fuel use for these buildings. The Energy Information Administration (EIA) does have data available on total commercial buildings and square footage or larger regions; number and square footage of buildings using LPG; and energy intensity. EIA's South Atlantic Region in the Commercial Building Energy Consumption Survey (CBECS) includes DC, MD, VA, DE, WV, NC, SC, GA, and FL.

Data Needs:

- Commercial buildings and total square footage: Data for all COG jurisdictions and region are collected from the CoStar Commercial Property Records. This database is available via subscription by COG's Department of Community Planning and Services Department (CPS).
- Total Commercial Floorspace and Commercial Square Footage using LPG: Values for the South Atlantic Region (most specific region) were derived from the EIA CBECS.
- LPG Energy Intensity: A value for the South Atlantic Region was derived directly from the EIA CBECS.

TRANSPORTATION AND MOBILE EMISSIONS

ON ROAD TRANSPORTATION

On Road Mobile Emissions

DESCRIPTION

On Road Mobile Emissions represent exhaust and evaporative emissions of carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4) from on road passenger and freight motor vehicles. On road mobile emissions account for approximately 1/3rd of metropolitan Washington GHG emissions. On Road emissions can be influenced by local governments through land use and urban design decisions and transportation infrastructure investments. Advancing electrification of the transportation system, overall improvement of the fuel economy, and increasing alternative trip modes play a particularly important role in reducing on road emissions.

METHODOLOGY

The On Road Transportation emission calculations generally follows the USCP recommended methodology as outlined in Appendix D, TR.1.A from Version 1.1 of the Protocol.

COG Department of Transportation Planning (DTP) staff prepare estimated GHG emissions and modeled vehicle miles traveled (VMT) data based on planning assumptions included in the Transportation Planning Board's (TPB) Constrained Long Range Plan (CLRP), COG Cooperative Forecasts (demographic data), vehicle registration (VIN) data, and modeling tools such as the TPB's travel demand model and the Environmental Protection Agency's (EPA) mobile emissions model.

Data for 2018 was based on the Visualize 2045 Long-Range Transportation Plan (adopted in October 2018 by the Transportation Planning Board), Round 9.1 Cooperative Forecasts, 2016 VIN data, Version 2.3.75 travel demand model, and MOVES2014b mobile emissions model. DTP staff provide GHG emissions estimates from EPA's mobile emission model for the District of Columbia, Maryland counties, Virginia counties, and the City of Alexandria.

DATA COLLECTION

DTP staff provide GHG emissions estimates by state, jurisdiction, and vehicle type. Emissions are based on both travel and non-travel related inputs to the MOVES model. Additional details on MOVES model inputs are described in COG Air Quality Conformity Analyses. Vehicle types include passenger cars, passenger trucks, motorcycles, school buses, transit buses, intercity buses, refuse trucks, light commercial trucks, motor homes, single unit short-haul trucks, single-unit long-haul truck, combination short-haul trucks, and combination long-haul trucks.

It is important to note that the modeled jurisdiction-level vehicle VMT input to the model is based on the travel occurring on the roadways in each jurisdiction, regardless of where the trips originate and terminate.

Data is provided by DTP staff for the TPB's Planning Area (excluding the Fauquier County urbanized area): City of Alexandria, Arlington County, Fairfax County (including Fairfax City and City of Falls Church), Loudoun County, Prince William County (including Manassas and Manassas Park), Charles County, District of Columbia, Frederick County, Montgomery County, and Prince George's County.

Data Needs:

- Population: Population data for all COG jurisdictions and the region are collected from COG's Cooperative Forecasts and the ACS.
- Emissions: Emissions of Atmospheric Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) from the EPA mobile emissions model is obtained from DTP staff.
- Vehicle Miles Travelled: Modeled VMT data by jurisdiction is obtained from DTP staff. This is not used to further calculate emissions; however, it is used as an indicator to support local jurisdictions in their understanding of resultant emissions.

AVIATION TRAVEL

Passenger Air Travel

DESCRIPTION

Passenger air travel emissions accounts for commercial aircraft emissions from major commercial airports serving the region and allocates those emissions to local communities based on users of the airport. The USCP states that aircraft emissions often represent more than 90 percent of airport related emissions.

METHODOLOGY

The Passenger Air Travel emission calculations generally follows the USCP recommended methodology as outlined in Appendix D, TR.6.D from Version 1.1 of the Protocol. COG's approach uses the best available data to estimate air travel passenger emissions by airport and allocates emissions by the percent of passengers traveling from a COG member jurisdiction to the airport. This includes all air passengers leaving a COG member jurisdiction to fly out of Baltimore-Washington International Thurgood Marshall Airport (BWI), Ronald Reagan Washington National Airport (DCA), and Washington Dulles International Airport (IAD). This includes personal travel and business travel by people who live, work, or were visiting a COG member jurisdiction.

To estimate emissions per airport, national aircraft emissions are downscaled based on the local to national ratio of revenue passenger miles for BWI, DCA, and IAD. Emissions are applied locally based on a community's contribution to each airport's originating passengers. This approach does not account for aircraft emissions and air passengers that are, for instance, flying into IAD and taking a connecting flight elsewhere.

DATA COLLECTION

For all originating air passengers departing from the region's three commercial airports – BWI, DCA, IAD – the biennial Washington-Baltimore Regional Air Passenger Survey provides readily available origin-destination data by mode of access, trip origination (home, non-home), resident status (resident, non-resident), and trip purpose (work, non-work), for base and forecast years. There is also readily available data on commercial aircraft emissions and passenger miles travelled for the airports serving the region through EPA and the Bureau of Transportation Statistics, respectively.

Data Needs:

- Number of Originating Air Passengers: Data for number of originating air passengers to each airport for each COG jurisdiction is collected from the Washington-Baltimore Regional Air Passenger Survey Geographic Findings Report. Data is pulled by "Jurisdiction" for the counties, District of Columbia, and the City of Alexandria. Data for the rest of the cities is pulled by "Airport Analysis Zone."

- Total Revenue Passenger Miles: Data for each airport and U.S. totals are from the Bureau of Transportation Statistics.
- U.S. Total Commercial Aircraft Emissions: Value in $MMTCO_2e$ are from: U.S. Environmental Protection Agency Inventory of U.S. GHG Emissions and Sinks.
- Total Enplanements: Volume for BWI, DCA, and IAD are from the COG Washington-Baltimore Regional Air Passenger Survey Geographic Findings Report.

RAIL TRANSPORTATION

Rail Transportation

DESCRIPTION

Rail Transportation calculates emissions resulting from MARC and Virginia Railway Express (VRE) trains carrying commuters from Maryland and Virginia. Combined average weekday ridership is approximately 60,000 passengers. These commuter rail services serve an important role in providing for a balanced intermodal transit for metropolitan Washington. Local jurisdictions may have influence on service levels in its community via supportive land use policies, infrastructure investments, and connecting transit services.

METHODOLOGY

The Commuter Rail Transportation emission calculations generally follow the USCP recommended methodology as outlined in Appendix D, TR.4 from Version 1.1 of the Protocol. In this approach, emissions are calculated from annual diesel consumption of commuter rail operators.

Maryland Transit Administration (MTA) and VRE reports diesel consumption for their full commuter rail operations, some of which occurs outside of metropolitan Washington. MTA and VRE annual diesel consumption are attributed to the region by the percent of stations located in the region – 59 percent of MTA's MARC stations and 75 percent of VRE stations are located in the region.

DATA COLLECTION

Diesel consumption of commuter rail systems (code CR) is readily available via the Federal Transit Administration's (FTA) National Transit Database. Data is downscaled by station locations and population because there is no public readily available, consistent data for both MTA and VRE commuter rail passenger travel activity.

Data Needs:

- Population: Population data for all COG jurisdictions and regions, as well as U.S. totals, are collected from the ACS.
- Diesel Consumption: Annual diesel consumption in gallons for the MTA and VRE as reported to the FTA National Transit Database.

EMISSIONS FROM OFF ROAD VEHICLES

Off Road Mobile Emissions

DESCRIPTION

Off Road Mobile Emissions account for nonroad equipment using gasoline, diesel, compressed natural gas and liquified petroleum gas. Nonroad mobile sources are broken up into the following categories:

- Lawn and garden equipment

- Airport service and ground equipment
- Logging equipment
- Recreational marine equipment
- Light commercial equipment
- Industrial equipment
- Construction equipment
- Agricultural or farm equipment
- Recreational land vehicles or equipment
- Railroad maintenance equipment

METHODOLOGY

The Off Road Transportation emission calculations generally follow the USCP recommended methodology as outlined in Appendix D, TR.1.8 from Version 1.1 of the Protocol. EPA's Motor Vehicle Emissions Simulator, version MOVES2014b, calculates past, present, and future emission inventories (i.e., tons of pollutant) for nonroad equipment. Off Road emissions data for Atmospheric Carbon Dioxide (CO_2) and Methane (CH_4) are pulled from the model for the inventory year.

Off Road categories excluded from the MOVES2014a/NONROAD2008 model include large commercial marine, passenger and freight locomotives, and aircraft. Metropolitan Washington does not have a large marine port, so excluding large commercial marine vessels is not a concern for the purposes of COG's GHG inventory work. Emissions from locomotives and aircraft are however included in separate calculations.

DATA COLLECTION

The MOVES 2014b model data outputs are available for the District of Columbia, Maryland counties, and Virginia counties and independent cities.

Data Needs:

- Population: Population data for all COG jurisdictions and the regions are collected from COG Cooperative Forecasts and the ACS.
- Emissions: Emissions in short tons of Atmospheric Carbon Dioxide (CO_2) and Methane (CH_4) from the EPA MOVES 2014b is obtained from COG Department of Environment's Air Quality Program.

WASTEWATER TREATMENT

FUGITIVE EMISSIONS FROM SEPTIC SYSTEMS

Septic System Emissions

DESCRIPTION

Septic Systems Emissions account for the fugitive emissions resulting from the physical settling and biologic activity during the treatment process in septic tanks. In 2015, approximately 6.5 percent of the population in the region was served by septic. According to the USCP, local governments can influence community septic through local building codes, providing and promoting incentives, etc.

METHODOLOGY

The Fugitive Emissions from Septic Systems calculations follow the USCP recommended methodology as outlined in Appendix F.WW.11 from Version 1.1 of the Protocol. The methodology estimates GHG emissions based on the population served by septic.

The Regional Wastewater Flow Forecast Model (RWFFM) and COG Cooperative Forecasts are leveraged to estimate population served by sewer. Total population subtracted from the population served by sewer provides a population served by septic estimate.

DATA COLLECTION

The RWFFM provides data that is available to use for the purposes of the GHG inventories. COG Cooperative Forecasts are used for population estimates.

Data Needs:

- Population served by septic

NITRIFICATION/DENITRIFICATION PROCESS N_2O EMISSIONS FROM WASTEWATER

Sewer System Emissions

DESCRIPTION

This calculation of Sewer System Emissions accounts for N_2O emissions during the treatment process at wastewater treatment plants (WWTPs). All WWTPs in the region operate with nitrification (converting ammonia to nitrate) and denitrification (converting nitrate into nitrogen gas) processes to remove nutrients from wastewater. This process protects the water quality of local waterways. More than 90 percent of the population in the region is served by a WWTP.

According to the USCP, wastewater utilities can potentially offset GHG emissions through renewable energy generation from biogas and/or biosolids, using reclaimed water to displace imported water, or producing biosolids as fertilizer for use.

METHODOLOGY

The Nitrification/Denitrification Process N_2O Emissions from Wastewater Treatment calculations follow the USCP recommended methodology as outlined in Appendix F.WW.7 from Version 1.1 of the Protocol. The methodology estimates GHG emissions based on the population served by sewer. The Regional Wastewater Flow Forecast Model (RWFFM) and COG Cooperative Forecasts are leveraged to estimate population served by sewer.

DATA COLLECTION

The RWFFM is processed annual by COG staff and outputs data that is available to use for the purposes of the GHG inventories. COG Cooperative Forecasts are used for population estimates.

Data Needs:

- Population served by sewer

PROCESS N_2O FROM EFFLUENT DISCHARGE TO RIVERS AND ESTUARIES

N2O Effluent Discharge Emissions

DESCRIPTION

N_2O Effluent Discharge Emissions account for the emissions resulting from treated wastewater that flows out of a treatment facility and discharged into waterways. Most of the nitrogen content is removed in the treatment process; however, when effluent containing nitrogen reaches the natural watershed a reaction occurs that releases N_2O emissions. This reaction makes up the vast majority of N_2O generated from a wastewater treatment plan (WWTP).

METHODOLOGY

The Process N_2O from Effluent Discharge to Rivers and Estuaries calculations follow the USCP recommended methodology as outlined in Appendix F.WW.12 from Version 1.1 of the Protocol. The methodology estimates GHG emissions based on the population served by sewer and daily Nitrogen loads.

The Regional Wastewater Flow Forecast Model (RWFFM) and COG Cooperative Forecasts are leveraged to estimate population served by sewer. Data inputs on Nitrogen loads are downloaded from CAST for the 2018 inventory (for previous inventories they were provided via personal communication from Chesapeake Bay Program staff) and converted from pounds/year to kg/day. They represent a simple average of the annual loads recorded by the Bay Program.

DATA COLLECTION

The RWFFM is processed by COG staff and outputs data that is available to use for the purposes of the GHG inventories. COG Cooperative Forecasts are used for population estimates.

Data Needs:

- Population served by sewer
- Daily Nitrogen Load: Values in kg N/day are retrieved from COG Department of Environmental Programs Wastewater Modeler.

AGRICULTURE

EMISSIONS FROM AGRICULTURAL ACTIVITIES

Enteric Fermentation

DESCRIPTION

Enteric Fermentation accounts for the methane produced from animal digestion in cows, sheep, goats, swine, and horses. According the USCP, enteric fermentation accounts for 25 percent of nationwide methane emissions from anthropogenic activities. The U.S. EPA report titled 'User's Guide for Estimating Methane and Nitrous Oxide Emissions from Agriculture Using the State Inventory Tool' states that a higher quality of feed produces lower emissions from these animals.

METHODOLOGY

The U.S. EPA's Emission Inventory Improvement Program developed a series of Excel-based State GHG Inventory Tools, which include an Agriculture Module. The Ag Module calculates methane (CH_4) and nitrous oxide (N_2O) emissions from the agricultural sources. Agricultural sources and activities

relevant to metropolitan Washington were calculated using this tool including Enteric Fermentation, Manure Management, and Ag Soils. The module takes your data inputs and applies state-specific data and factors to calculate emissions. The methodologies applied in the tool are generally consistent with EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

The USCP does offer similar suggested calculations for enteric fermentation and manure management, where national default factors are applied. While Ag emissions calculated offline can be documented in ClearPath, it does not currently offer a calculator that estimates emissions. At this time, EPA's State Inventory Tool offers the most streamlined calculation process with the most locally relevant default factors for COG's GHG inventory work.

DATA COLLECTION

Metropolitan Washington data inputs into the EPA's State GHG Inventory Tool are pulled at the county-scale from the EPA Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). CAST is a web-based nitrogen, phosphorus and sediment load estimator tool that streamlines environmental planning.

Data Needs:

- Livestock: Livestock population ('000 head) for dairy cows, beef cattle, sheep, goats, swine, horses derived from the Chesapeake Assessment Scenario Tool.

Manure Management

DESCRIPTION

Manure Management accounts for emissions from management systems that stabilize or store livestock manure. It accounts for manure from dairy cows, beef cattle, sheep, goats, swine, horses and poultry operations. Methane (CH_4) is a natural by-product of manure decomposition and nitrous oxide (N_2O) is also produced during the storage and treatment of animal manure.

The U.S. EPA report titled 'User's Guide for Estimating Methane and Nitrous Oxide Emissions from Agriculture Using the State Inventory Tool' states that the greater energy content of the feed results in an increased capacity to produce CH_4 in manure. In addition, the report states that the amount of N2O released depends on the system and duration of waste management.

METHODOLOGY

EPA's Emission Inventory Improvement Program developed a series of Excel-based State GHG Inventory Tools, which include an Agriculture Module. The Ag Module calculates CH_4 and N_2O emissions from the agricultural sources. Agricultural sources and activities relevant to metropolitan Washington were calculated using this tool including Enteric Fermentation, Manure Management, and Ag Soils. The module takes your data inputs and applies state-specific data and factors to calculate emissions. The methodologies applied in the tool are generally consistent with EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

The USCP does offer similar suggested calculations for enteric fermentation and manure management, where national default factors are applied. While Ag emissions calculated offline can be documented in ClearPath, it does not currently offer a calculator that estimates emissions. At this time, EPA's State Inventory Tool offers the most streamlined calculation process with the most locally relevant default factors for COG's GHG inventory work.

DATA COLLECTION

Metropolitan Washington data inputs into the EPA's State GHG Inventory Tool are pulled at the county-scale from the EPA Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). CAST is a web-based nitrogen, phosphorus and sediment load estimator tool that streamlines environmental planning.

Data Needs:

- Livestock: Livestock population ('000 head) for dairy cows, beef cattle, sheep, goats, swine, horses, pullets, chickens, broilers, and turkeys from the Chesapeake Assessment Scenario Tool.

Ag Soils

DESCRIPTION

Ag Soils account for nitrous oxide (N_2O) emissions from animals, crop production, and fertilizer application. The U.S. EPA report titled 'User's Guide for Estimating Methane and Nitrous Oxide Emissions from Agriculture Using the State Inventory Tool' states that N_2O is naturally produced in soils; however, animal and crop management practices and fertilizer application increase the amount of N_2O emitted. Higher levels of N_2O are a result of:

- The type of animal waste management systems used;
- Cultivation of certain types of nitrogen-fixing crops;
- Crop residues remaining on agricultural fields; and
- The use of synthetic and organic fertilizer in ag and urban soils.

METHODOLOGY

The U.S. EPA's Emission Inventory Improvement Program developed a series of Excel-based State GHG Inventory Tools, which include an Agriculture Module. The Ag Module calculates methane (CH_4) and N_2O emissions from the agricultural sources. Agricultural sources and activities relevant to metropolitan Washington were calculated using this tool including Enteric Fermentation, Manure Management, and Ag Soils. The module takes your data inputs and applies state-specific data and factors to calculate emissions. The methodologies applied in the tool is generally consistent with EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

The USCP does offer similar suggested calculations for enteric fermentation and manure management, where national default factors are applied. While Ag emissions calculated offline can be documented in ClearPath, it does not currently offer a calculator that estimates emissions. At this time, EPA's State Inventory Tool offers the most streamlined calculation process with the most locally relevant default factors for COG's GHG inventory work.

DATA COLLECTION

Metropolitan Washington data inputs into EPA's State GHG Inventory Tool are pulled at the county-scale from the EPA Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). CAST is a web-based nitrogen, phosphorus and sediment load estimator tool that streamlines environmental planning.

Data Needs:

- Livestock: Livestock population ('000 head) for dairy cows, beef cattle, sheep, goats, swine, horses, layers (pullets and chickens), broilers, and turkeys from the Chesapeake Assessment Scenario Tool (CAST).
- Crops: Crop production ('000 bushels) for corn for grain, all wheat, and soybeans from CAST.
- Fertilizer: Fertilizer applied (kg N) for synthetic fertilizers, manure, and biosolids.

SOLID WASTE TREATMENT

Solid Waste

WASTE GENERATION

Landfill Waste Generation

DESCRIPTION

Landfill Waste Generation accounts for the emissions resulting from waste generated by the community in a year and disposed of at a landfill. In other words, it accounts for the resultant methane emissions from the decomposition of biologic solid waste produced by the community that year. Methane capture has a significant influence over resulting GHG emissions. If a landfill receiving waste has no methane capture, the resultant GHG emissions are much higher. According to the USCP, local jurisdictions' municipal solid waste (MSW), recycling, and composting programs can influence the amount of waste generated, the methods of disposal, and locations.

METHODOLOGY

The Landfill Waste Generation emission calculations follow the USCP recommended methodology as outlined in Appendix E, SW.4 from Version 1.1 of the Protocol. The calculations are based on tons of MSW from each jurisdiction going to a landfill and whether the receiving landfills have methane capture. It is important to make this distinction and identify how many tons are annually disposed of at these landfills.

DATA COLLECTION

The best available MWS data from local and regional sources was used to calculate these emissions. Unlike other activities in this inventory, there is not a regional, state, or federal source of MSW data that comprehensively reports data in the way that is needed for GHG inventory calculations.

Data Needs:

- Municipal Solid Waste (MSW): Annual mass in tons of MSW landfilled retrieved from local and regional sources.
- Methane Collection: Identify landfills that regularly receive MSW from each jurisdiction and whether those landfills have methane collection using the EPA FLIGHT Tool.

COMBUSTION OF SOLID WASTE GENERATED BY THE COMMUNITY

Combustion of Solid Waste

DESCRIPTION

The Combustion of Solid Waste accounts for the emissions resulting from municipal solid waste (MSW) generated by the community in a year and disposed of at a waste-to-energy (WTE) facility. WTE facilities burn garbage and typically generate steam and/or electricity from the combustion of MSW. According to the USCP, local jurisdictions' MSW, recycling, and composting programs can influence the amount of waste generated, the methods of disposal, and locations.

METHODOLOGY

The Combustion of Solid Waste Generated by the Community emission calculations follow the USCP recommended methodology as outlined in Appendix E, SW.2.2 from Version 1.1 of the Protocol. The

calculation used is SW.2.2a. The calculations are based on tons of MSW from each jurisdiction going to a WTE.

DATA COLLECTION

The best available municipal MWS data from local and regional sources was used to calculate these emissions. Unlike other activities in this inventory, there is not a regional, state, or federal source of MSW data that comprehensively reports data in the way that is needed for GHG inventory calculations.

Data Needs:

- Municipal Solid Waste (MSW): Annual mass in tons of MSW combusted retrieved from local and regional sources.

OTHER

Process and Fugitive Emissions

SUBSTITUTES FOR OZONE DEPLETING SUBSTANCES

Hydrofluorocarbon Emissions (HFC)

DESCRIPTION

Hydrofluorocarbons (HFC's) are a type of GHG and are comprised of several organic compounds composed of hydrogen, fluorine, and carbon. HFC's are produced synthetically and are commonly used in air conditioning and refrigerants in place of older halons and chlorofluorocarbons (CFC's), which were attributed to the depletion of Earth's Ozone layer. Following the implementation of the Montreal Protocol, HFC's gradually replaced CFC's because of their minimal impact on the Ozone layer, having an Ozone depletion potential of zero. However, HFCs are potent greenhouse gases (HFC's are 3,830 times more potent than CO_2) with high global warming potentials.

METHODOLOGY

HFC emissions in this inventory represent GHG emissions from substitutions for Ozone depleting substances. Total U.S emissions from substitutes for Ozone depleting substances are scaled locally by population to estimate jurisdictional and regional values. Substitutions for Ozone depleting substances primarily result in HFC emissions; however, small amounts of perfluorocarbon (PFC) emissions also result from this source.

DATA INPUTS

Local data on substitutes for Ozone depleting substances is not available. It would take extensive research and local surveys to develop this data. Although emissions from these substances continues to expand, it only accounts for a small portion of emissions. The U.S. Environmental Protection Agency's annual inventory reports on GHG emissions calculates nationwide emissions for substitutes for Ozone depleting substances.

Data Needs:

- Population: Population data for all COG jurisdictions and the region are collected from the ACS.

- U.S. Emission of Ozone Depleting Substances: National data for HFC emissions is recorded in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$) from the U.S. EPA, Inventory of U.S. GHG Emissions and Sinks.

FUGITIVE EMISSIONS FROM NATURAL GAS DISTRIBUTION

Natural Gas Fugitive Emissions

DESCRIPTION

Natural Gas Fugitive Emissions accounts for emissions resulting from local natural gas system losses within the community.

METHODOLOGY

The Fugitive Emissions from Natural Gas emission calculations uses the ClearPath calculator developed after the latest version of the USCP was published (Version 1.1). The fugitive emissions are calculated based on a leakage rate for total annual natural gas consumption. The ClearPath calculator uses a leakage rate of 0.3 percent.

DATA COLLECTION

Data from the Metropolitan Washington Annual Utility survey needs to first be collected and analyzed for the inventory year prior to completing these steps.

Data Needs:

- Natural Gas Consumption: Total Annual Therms for each jurisdiction from the analyzed results of the Metropolitan Washington Annual Utility Survey.

APPENDIX G: BAU AND 2030 SCENARIO ASSUMPTIONS

Appendix Table 3: Business-As-Usual Projection Assumptions

Emissions Activity	BAU Assumptions
Residential Energy	COG Cooperative Forecasts Round 9.1 household growth by COG member jurisdiction
	Applied to typical housing mix in each community (Single Family Detached, Attached, Apartments 2-4 Units, Apartments 5+ Units)
	Typical energy use intensity by housing type
Commercial Energy	9.1 Cooperative Forecasts employment growth by COG member jurisdiction
	Historic job growth & commercial construction -> SQFT new construction / job
	New building mix by Core, Inner, Outer areas from COG Commercial Construction Report
	Typical energy use intensity by building type (office, retail, flex/other)
On-Road Mobile Emissions	Adopted Transportation Planning Board projections from Vision 2045
	Transportation Demand Model 2.3.75
	Uses Visualize 2045 Transportation Networks & 9.1 Cooperative Forecasts as inputs
	EPA MOVES2014b
	Incorporates incremental improvements in average fuel economy
Air and Rail Travel	Passenger growth based on COG Regional Air Passenger Origin/Destination Forecast
	Percent increase derived from Transportation Planning Board projections of future ridership
Off-Road Mobile Emissions	Held constant
Agriculture	All sources (soils, livestock, manure) decreased at annual rate of recent loss in farmland (2007-2012) from COG What our Region Grows Report, 2017
Waste (Solid Waste and Wastewater), HFCs	Proportional increase with population
Fugitive Natural Gas	Driven by increases in natural gas consumption

Appendix Table 4: 2030 Scenario Assumptions

GHG Emission Reduction Activity	Assumptions
Renewable Portfolio Standards	Current standards (DC 87 percent, MD 50 percent, Northern VA 38 percent by 2030)
Other Renewables	Distributed generation: > 200,000 additional solar systems, equivalent to 24 percent of single-family homes
	Green power purchases: continued 10 percent annual growth
	Renewable natural gas (RNG): >16 percent of gas supply from RNG derived from ICF Study on Use of Biofuels in the region.
Building Policies and Programs	Zero energy new construction: All new construction net zero energy by 2030
	Deep retrofits of existing buildings: 2 percent of residential and commercial deep retrofits annually
Zero Emission Vehicle Deployment	EV adoption rates of >20 percent light duty cars, >9 percent light duty trucks, >4 percent medium/heavy duty trucks, and >30 percent transit buses. Assumptions derived from National Renewable Energy Laboratory Electrification Futures Study high EV adoption rates.
Transportation Policies and Programs	Activity centers: 75 percent new housing in Activity Centers with high capacity transit. Assumptions derived from COG Multi-Sector Work Group Final Technical Report and COG Future of Housing Report.
	Travel demand management, transit incentives, transit fare reduction, road pricing, non-road engine emission reduction, and commercial aviation improvement assumptions from COG Multi-Sector Work Group Final Technical Report.
Fugitive Emission Reduction	HFCs and gas leak repair assumptions from COG Multi-Sector Work Group Final Technical Report.
Zero Waste Policies and Programs	80 percent diversion by 2030
Sequestration	Sequestration assumptions from COG Multi-Sector Work Group Final Technical Report.