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 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 (CO_2), methane (CH_4), nitrous oxide (N_2O), 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

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

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

CITY OF GREENBELT
- Sustainability Plan Framework, 2013
  - o 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
  - o Meet mandated Maryland level of 40 percent below 2006 levels by 2030
- Rockville Energy Action Plan, 2013
- Strategy for a Sustainable Rockville, 2007
  - o 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
  - o Zero GHG emissions by 2035
- Sustainable Energy Action Plan, 2014
  - o 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
  - o Reduce CO_2 emissions in 80 percent below 1990 levels by 2010.

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

MONTGOMERY COUNTY
- Emergency Climate Mobilization Resolution, 2017, and Climate Mobilization Report, 2018
  - o 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
  - o 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
  - o 10 percent reduction in emissions every 5 years through 2050, for a total reduction of 80 percent below the baseline year of 2005
  - o Adopted these to be consistent with the Montgomery County, Prince George's County and COG goals.

Virginia

ARLINGTON COUNTY

- Community Energy Plan Update, 2019
  - o County-wide carbon neutral by 2050
- Community Energy Plan, 2013
  - o 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
  - o 50 percent below 2005 levels by 2030
  - o 80 - 100 percent below 2005 levels by 2050
- Energy and Climate Change Action Plan, 2011
  - o By 2012, reduce GHG emissions to 2005 levels;
  - o By 2020, reduce GHG emissions by 20 percent below 2005 levels
  - o 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
  - o County-wide goal to reduce GHGs from 3.85 million metric ton to 3.0 million metric ton by 2040
  - o 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
  - o 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.

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 (CO_2), methane (CH_4), Nitrous oxide (N_2O), 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$_2$O, 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$_2$O	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$_2$O	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$_2$O	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$_2$O	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$_2$O 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$_2$O 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$_2$O	Appendix F, WW.7	High
	Process N2O from Effluent Discharge to Rivers and Estuaries *	Fugitive N$_2$O	Appendix F, WW.12	High
AGRICULTURE				
Agriculture	Emissions from Agricultural Activities	CH$_4$, N$_2$O	Alternate Method - EPA State Inventory Tool, AG Module	Medium
	Emissions from Stationary Fuel Combustion	CO$_2$, CH$_4$, N$_2$O	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$_2$e	NE	N/A
	Combustion of Solid Waste Generated by the Community *	Fossil CO$_2$, N$_2$O, CH$_4$ (biologic CO$_2$ optional)	Appendix E, SW.2.2	Medium
	Biologic Treatment of Solid Waste (Composting)	CO$_2$, CH$_4$, N$_2$O	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 (CO_2), nitrous oxide (N_2O), and methane (CH_4) from on road passenger and freight motor vehicles. On road mobile emissions account for approximately $1/3^{rd}$ 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$_2$e 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$_2$O FROM EFFLUENT DISCHARGE TO RIVERS AND ESTUARIES

N2O Effluent Discharge Emissions
DESCRIPTION

N$_2$O 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$_2$O emissions. This reaction makes up the vast majority of N$_2$O generated from a wastewater treatment plan (WWTP).

METHODOLOGY

The Process N$_2$O 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$_2$O) 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$_2$e) 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.