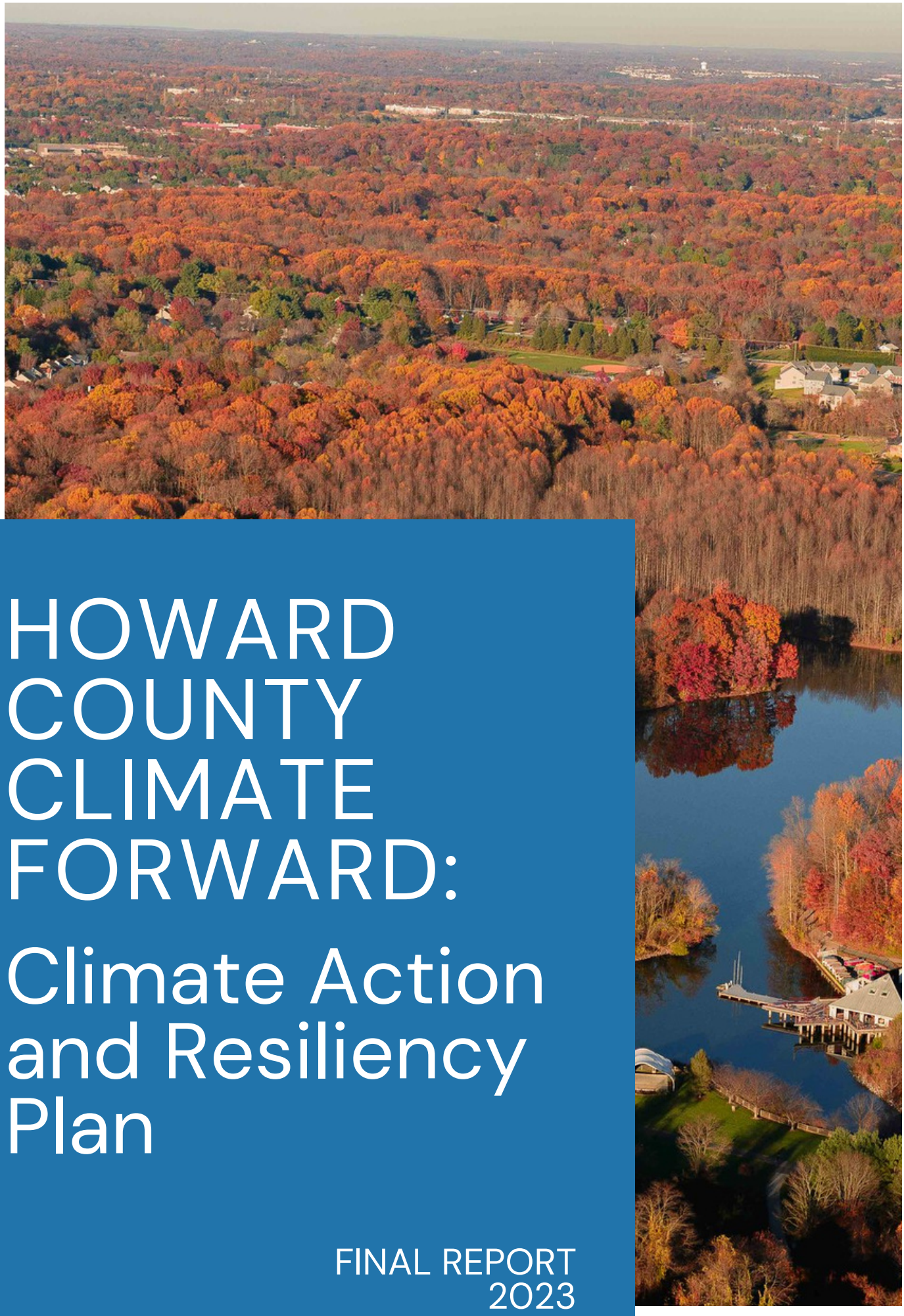


HOWARD COUNTY CLIMATE FORWARD:

Climate Action and Resiliency Plan

FINAL REPORT
2023

I am honored to present Howard County's Climate Forward: Climate Action and Resiliency Plan.

Howard County is a leader in the fight against climate change. We have cut our energy use through building energy upgrades and have entered into the largest solar power purchase agreement in the state. Since 2019, Howard County has also planted more than 65,000 trees, strengthened our forest conservation laws, and invested in green infrastructure.

While these are significant accomplishments, we cannot be satisfied with our past successes. There is much more to do. Well-established science tells us that climate change is one of the most urgent challenges of our generation and that we are running out of time to act.

This plan sets an ambitious course for reaching a 60% reduction in greenhouse gas (GHG) emissions by 2030 and net zero by 2045. Based on extensive research, there are four areas Howard County will focus on to reach these goals: Energy, Transportation, Waste, and Nature-Based Solutions. These efforts will reduce our GHG emissions and remove greenhouse gasses in the air by protecting forests and increasing native trees, plants, and healthy soils.

We know we are already seeing the effects of climate change right here in Howard County and we must do our absolute best to reduce the causes of the damaging effects of climate change that are predicted for the future. Climate Forward is the first Howard County climate plan to focus on resiliency. The research that went into Climate Forward shows that flooding and extreme heat are the most pressing and dangerous outcomes. Climate Forward includes making sure our residents are prepared for emergencies, reducing heat islands, improving stormwater management to reduce flooding, and enhancing ecosystems. We will prioritize our projects with a special emphasis on vulnerable and underserved communities.

Climate change is not solely an environmental issue. It transcends agencies and departments, and includes essential topics such as health, infrastructure, economics, and more. Climate Forward outlines specific next steps including setting timelines and identifying implementors for each action. These implementation steps were devised from the ground up, with extensive collaboration with all Howard County Government agencies.

We do not do this work alone. There are many businesses, state and federal agencies, and non-profit organizations that we will continue to engage as partners to achieve these goals. Climate Forward also includes a community call to action to harness the power of our residents to bring the whole community together in this effort.

I am thrilled that the Climate Forward Plan is complete. But in many ways, publishing this plan is only the start of our work. Climate Forward will not be a plan that sits on a shelf; it will be an evolving effort that incorporates new ideas and technologies as they unfold.

I am grateful to be a part of a community that is so passionate about protecting our environment for current and future generations. Thank you to our dedicated County staff, partners, and community members for creating Climate Forward.

I look forward to our continued partnership to ensure our environment is clean and sustainable for current and future generations.

Calvin Ball
Howard County Executive

Executive Summary

Howard County Climate Forward: Climate Action and Resiliency Plan is science-based and focused on immediate and practical action. To develop this plan, Howard County's Office of Community Sustainability conducted the following research and public participation efforts:

- Review of relevant local and regional climate action plans and climate vulnerability assessments.
- Community-wide and government operations GHG emissions inventory for calendar year 2019.
- Expert input from subcontractor ICF to prepare Mitigation and Resiliency Strategies based on climate science and maximum impact.
- Community survey, specifically reaching out to underserved populations, to gather feedback on climate emergency preparedness.
- Meetings with internal and external stakeholders to generate ideas and get a complete picture of the work already in progress.
- Focus groups across agencies to refine Mitigation and Resiliency Strategies.
- Public meetings and written comments on both the Preliminary Report and the draft Final Report.

This bold and historic plan includes:

- Detailed information about Howard County's climate vulnerabilities.
- The County's most recent community-wide greenhouse gas (GHG) emissions inventory.
- New climate goals.
- GHG modeling results showing GHG emissions reductions expected from mitigation strategies.
- Specific Mitigation and Resiliency climate solutions, including strategies, actions, and implementation plans for each action.
- Appendices with details about methods used to develop the inventory, vulnerability assessment, GHG emissions reduction modeling and information about Howard County government's existing sustainability and climate efforts and programs.

Howard County Climate Forward will serve as a science-based and shovel ready workplan for every department and level of Howard County government. It also includes some recommendations for what partners and individuals can do. In addition, for the first time, Howard County is including resiliency, adaptation, carbon sequestration, and a focus on underserved populations into its climate action plan.

A lot has happened since the last Howard County Climate Action Plan published in 2015. Howard County has experienced some significant instances of extreme weather events, including the severe flooding of historic Ellicott City in 2016 and 2018, heat waves, and weather-related disruptions to electricity.

Climate projections indicate that the County will experience more intense storms, hotter days, local flooding, increased pollution, and other impacts as the climate changes. These hazards could damage and undermine public health, critical infrastructure, and essential resources in ways that pose a direct threat to human health and the vitality of Howard County's operations, economy, and community. Howard County must do its part to reduce greenhouse gas emissions and be better prepared for the harsher weather conditions that climate change will bring.

Moreover, there is now an even stronger understanding about how certain communities and populations are affected differentially by the impacts of climate change, and how solutions can be applied in a way to achieve environmental equity.

By undertaking Howard County Climate Forward, there is increasing momentum across all levels of the government, as well as continued public support, to act. With new and large sources of funding becoming available from the federal government to address climate change and from the state government through the recently passed Maryland Climate Solutions Now Act to reduce greenhouse gas emissions statewide, it is an auspicious time to release a new and ambitious climate action strategy for the County.

This 2023 Climate Action and Resiliency Plan builds on Howard County's existing efforts to reduce emissions, increase resiliency, and achieve environmental equity. This plan identifies strategies to reduce greenhouse gas emissions, sequester (store) carbon, and achieve greater resilience against the increases in extreme weather that are projected to occur.

This report includes the most impactful and equitable strategies to reduce GHG emissions for the entire county and from all sectors, public and private. It also includes strategies for carbon storage and for increasing resiliency of infrastructure, ecosystems, and communities to expected changes in weather and climate. By following the recommendations in this plan, Howard County will:

- **Reduce greenhouse gas emissions by 70% by 2045** compared with projected 2045 emissions. These reductions will come primarily from converting the community light-duty vehicle fleet to electric vehicles, reducing miles driven, increasing the use of renewable energy, and improving energy efficiency. While this doesn't fully achieve the net zero goal by 2045, it lays an excellent foundation of priority strategies to focus on for the next 3-5 years. Howard County plans to build on this foundation to achieve the net zero emissions goal by increasing carbon storage with nature-based climate solutions, advocating for better state and federal policies, adopting new technologies, and calling on individuals, organizations, and businesses to join our efforts to reduce GHG emissions and increase carbon storage.
- **Increase carbon sequestration** by improving soil health of natural and working lands, protecting and maintaining existing forests and other natural resources, planting more trees and deep-rooting native plants, replacing turf grass with native plant gardens, and pursuing other nature-based climate solutions.
- **Increase community resilience to extreme weather events**. Increased resilience will manifest in many ways. First, the strategies will promote infrastructure investments that will enable Howard County's infrastructure to better withstand extreme weather events. For example, where there are heavy rains, there will be less localized flooding. Second, it will enable communities to be more prepared to deal with the impacts that are experienced. For example, there will be improved communication about what to do and what not to do during major weather events; households will be better prepared for power outages; and improved insulation and energy efficiency will provide a buffer against rising energy bills.
- **Increase interdepartmental coordination and environmental equity across programs.** A major focus of Howard County Climate Forward is a deep level of engagement from nearly every department, bureau, and office within County government. This interdepartmental cooperation informed the development of a comprehensive climate action and resiliency plan and will continue during implementation. Climate Forward also emphasizes equity, inclusion, and justice in every initiative.

Climate Forward is more than just a document. It is a strategic workplan for every level of County government across all departments and staff. Recognizing that achieving these goals is dependent upon many variables, such as financial resources, technological advancements, and community participation, this workplan will remain fluid. Climate Forward outlines the best approach to reaching the goals given current knowledge and ability to implement actions. However, adaptive management will be utilized as the County continues to explore the most cost effective, equitable, and efficient methods for achieving climate goals over time. The County anticipates gradual advancements toward the goals in the first year or two while forming partnerships, researching best implementation strategies, beginning to implement programs, and increasing the community's understanding of their role. Exponential advancements are expected in later years as new initiatives are underway, technology improves, and community participation rises. Over time, the means and timeline for achieving the actions laid out in Climate Forward may vary from this document, but the goals will remain the same. The County will report progress annually and will include any adjustments in implementation steps, timelines, or metrics in these annual reports.

Continued intergovernmental cooperation and improved community services are ensured through the appointment of a Climate Action Subcabinet. The Subcabinet will host interdisciplinary workgroups that meet regularly to move climate action plan implementation forward in the most innovative, equitable, collaborative, and efficient manner.

Background

Howard County has a strong history of acting on climate change. Howard County released its first Climate Action Plan in 2010. This plan set targets to reduce greenhouse gas emissions 7 percent below 2007 levels by 2012, and 80 percent by 2050. These emission reductions were to be achieved primarily through strategies that targeted building energy, transportation, and renewable energy development.

The County's next Climate Action Plan, published in 2015, reviewed 2012 data and demonstrated that Howard County had exceeded the original goal and reduced emissions from Howard County government operations 12 percent below 2007 levels by 2012. The 2015 Climate Action Plan focused primarily on County government operations and did not include inventories, goals, or strategies for the private sector.

In 2019, during a void in national leadership on climate change, Howard County Executive Calvin Ball stepped forward with other local leaders across the country and committed Howard County to meeting internationally agreed upon protocols to reduce GHG emissions enough to avoid the worst of potentially life-threatening heatwaves, sea level rise, and ecosystem loss. Also in 2019, Howard County was the first county in the United States to accept the Natural and Working Lands Challenge to actively pursue nature-based climate solutions to maximize opportunities to reach net zero emissions through carbon storage in healthy soils, forests, meadows, and farmland. At that time, Howard County set new, more ambitious goals for greenhouse gas emissions reductions from County government operations of 45% below 2010 levels by 2030 and net zero emissions by 2050.

Howard County has further demonstrated its commitment to combating climate change through an impressive array of sustainability and quality of life initiatives across the County's departments. Howard County's commitment to sustainability is further demonstrated by becoming the first county in the U.S. to achieve a LEED Platinum designation from the U.S. Green Building Council's LEED for Cities and Communities program.

While focused on making this great progress on fighting climate change, Howard County has not updated its Climate Action Plan since 2015 – until now. It is important to have regular updates to the County's Climate Action Plan, especially as new climate science is published that may impact GHG emissions reduction goals and as climate change impacts lead to more hazardous conditions such as heat waves and extreme storms. In recent years, the County has experienced damaging floods, more frequent and severe heat events, and more power disruptions due to severe storms. Climate scientists project that these hazards will continue to increase in the future. These changes in climate can threaten public health, cause expensive damage to infrastructure, increase utility bills, and reduce the quality of life in the County.

2022 Executive Order Climate Goals

Recent reports from the Intergovernmental Panel on Climate Change (IPCC) show that society needs to act even more quickly and aggressively than previously thought to avoid the most catastrophic impacts of climate change. Using the research already accomplished through Howard County Climate Forward, and with urgency in mind, Howard County Executive Calvin Ball decided to answer this challenge by creating new greenhouse gas emissions goals through an Executive Order.

Executive Order 2022-12 surpasses both Maryland and federal greenhouse gas emissions reduction goals. Howard County's new greenhouse gas emissions reduction goal is to achieve a 60% reduction over 2005 levels by 2030 and net zero emissions by 2045. The Executive Order also formally adopted the Climate Focused and Equitable Governance Strategies outlined in this plan, which ensure that equity is incorporated into the County's governance approach to climate action and is accounted for in all decision-making processes.

Policy Context

This Climate Action and Resiliency Plan is being released at an exciting—and critical—time. In 2021 and 2022, the US government passed two major pieces of legislation that provide substantial funding opportunities for reducing greenhouse gas emissions and increasing resilience: Infrastructure Investment and Jobs Act (IIJA) in 2021 and the Inflation Reduction Act (IRA) in 2022. These federal acts authorize a substantial amount of funding to be used to combat climate change and to increase the resiliency of our nation's infrastructure.

These Acts come at an opportune time, as the State of Maryland, the Baltimore Metropolitan Council (BMC), and Howard County have already taken important steps toward addressing climate change. Most notably, Maryland passed the Climate Solutions Now Act in April 2022, which sets an aggressive goal of achieving net-zero greenhouse gas emissions by 2045. Meanwhile, BMC and Howard County have already established foundational efforts to tackle both greenhouse gas emissions and resiliency.

Therefore, this Climate Action Plan is being released at a time with strong policy mandates, unprecedented funding opportunities, and foundational efforts to combat climate change. With the support of this broader context, the strategies and actions presented in this Plan will guide Howard County in achieving meaningful reductions in emissions and substantially increasing resiliency to climate change hazards, while meeting the requirements set forth in the state's Climate Solutions Now Act.

National, state, and local policies and programs of note are:

- Climate Solutions Now Act (Maryland)
- Inflation Reduction Act (Federal)
- Infrastructure Investment and Jobs Act (Federal)
- American Innovation and Manufacturing Act (Federal)

To learn more about these policies and programs, see the Federal and State Climate Action Section.

Regional and County Efforts

HoCo by Design

At the same time as developing this Climate Action and Resiliency Plan, Howard County also has been in the process of updating its general plan – an update that occurs approximately once every decade. The new general plan, which will be considered by the County Council in 2023, is called HoCo by Design. Developing these plans at the same time was helpful as Howard County is focused on incorporating climate action into all of its major plans. Howard County's Office of Community Sustainability and its Department of Planning and Zoning worked together to ensure that these plans are complementary and achieve climate solutions for years to come.

Emergency Management Plans

Howard County's Office of Community Sustainability and Office of Emergency Management coordinated extensively on the development of Howard County Climate Forward. There are several plans published by the Office of Emergency Management that address climate hazards and how the County responds to disasters, such as the Howard County Hazard Identification Risk Assessment (HIRA) Plan, Howard County Hazard Mitigation Plan, and the Howard County Comprehensive Emergency Response and Recovery Plan (CERRP). Office of Community Sustainability reviewed these plans to ensure that Climate Forward is coordinated with and responsive to these emergency management plans.

Other Regional Plans and Studies

Howard County Climate Forward was developed to complement and to incorporate relevant findings from other regional plans and studies. These include several efforts by the Baltimore Metropolitan Council (BMC), including its Vulnerable Populations Index that helps identify geographic locations with high concentrations of underserved populations that may be more vulnerable to climate change than other groups. In addition, BMC and the Baltimore Regional Transportation Board (BRTB) completed a resource guide for Departments of Public Works (DPWs) and Departments of Transportation (DOTs) in the Baltimore Region for addressing climate change. This guide is focused on ensuring that local DPWs and DOTs have key information on how the climate is projected to change in each county of the BMC region. The purpose is to help them make climate-informed decisions about infrastructure planning, design, maintenance, and more. Ensuring that future climate is considered when making these decisions is an important step toward achieving more resilient infrastructure.

In addition, Howard County reviewed reports by the Intergovernmental Panel on Climate Change, the Maryland Commission on Climate Change and recent Climate Action Plans produced by nearby jurisdictions. Some of these jurisdictions include Montgomery County, Prince George's County, Baltimore County, and Fairfax County. Howard County also reviewed many climate vulnerability assessments from across the Country to ensure that this plan included the most critical sectors and considered all possible climate impacts to those sectors. The Columbia Association's Climate Vulnerability Assessment was particularly helpful for local vulnerability information.

Other County Initiatives

Howard County Climate Forward builds on a wide variety of successful County initiatives to reduce GHG emissions and increase climate resiliency at the local level. Some of these include the Feed the Green Bin residential curbside food composting program, recent installation of dozens of new, publicly available electric vehicle (EV) charging stations, several major tree planting programs, extensive disaster risk management, the Ellicott City Safe and Sound flood management program, energy efficiency improvements at County facilities, quick adoption of new building codes, and much, much more. There are too many of these initiatives to detail here, but more information is provided about County initiatives that relate to each mitigation and resiliency action in the relevant sections of this document. In addition, an extensive, though not exhaustive, list of County climate initiatives is provided in Appendix G.

Overview of Approach

This plan contains priority strategies that will help the County achieve its emission reduction goals and increase resiliency. The plan uses the best available data and science to determine the most impactful strategies to pursue. The plan takes a long-term view, with projections to key milestones of 2030 and 2045, but also focuses on implementation over the next 5 years. Progress will be assessed annually, and staff will review and revise Climate Forward as needed after five years. A lot has changed in the last five years. Five years ago, there was no Climate Solutions Now Act, Inflation Reduction Act or Infrastructure Investment and Jobs Act. The electric vehicle industry was also a lot different just a few years ago and the push for building electrification was not as organized.

Climate Forward is a culmination of both analytical work and stakeholder input—both of which played an essential, but different, role in selecting the strategies and actions for this Plan. At the outset, Howard County committed to ensuring strategies were selected based on sound and objective analysis.

The County developed a greenhouse gas inventory and projections using the International Council for Local Environmental Initiatives (ICLEI's) ClearPath tool. The inventory and projections were critical to understanding the primary drivers behind the County's emissions, and how those drivers may change in the future. Using this information, the County identified strategies in the Energy and Built Environment, Transportation, and Solid Waste sectors, which are

responsible for more than 99% of the County's estimated emissions included in this Plan. Thus, the County can focus on strategies that will have the most impact on emissions reductions.

To identify appropriate resiliency strategies, Howard County needed to first identify its greatest risks from climate change. To do so, The County used the Temperate Tool to assess its primary climate change risks. The findings of this assessment revealed that the top priority climate hazards facing Howard County are extreme heat, flooding, and extreme weather. Therefore, the strategies in this document focus on addressing risks associated with those hazards.

Finally, the County conducted a separate heat assessment. Heat is expected to increase substantially in the future, and impacts can be experienced unequally across geographies and populations. Therefore, the County completed a spatial analysis to identify the areas of greatest anticipated heat increases and where they overlap with concentrations of underserved populations, using Baltimore Metropolitan Council's Vulnerability Index for each Census tract in Howard County.

The methods, data, and assumptions used in these analyses are documented in later sections of this report.

While objective analysis is essential for identifying priority strategies, Howard County knows that successful implementation requires robust input from the County departments that will be affected by the strategies. Therefore, the County conducted extensive stakeholder engagement throughout the process. These engagements included both internal Howard County government stakeholders and external stakeholders.

Determining the specific implementation steps has been a thorough and collaborative process. This plan is not intended to be a top-down approach. Every effort was made to be inclusive and obtain knowledge and buy-in within Howard County government operations.

Preliminary conversations with various County departments were held to exchange ideas about Climate Forward, and to start defining the role that each department would have in creating and implementing strategies and actions.

Internal stakeholders included:

- Department of Community Resources and Services
- Department of Finance
- Department of Housing and Community Development
- Department of Inspections, Licenses, and Permits
- Department of Planning and Zoning
- Department of Recreation and Parks
- Department of Public Works (including Bureaus of Facilities, Highways, Engineering, and Environmental Services)
- Department of Technology and Communications Services
- Office of Central Fleet
- Office of Community Sustainability
- Office of Emergency Management
- Office of Human Rights and Equity
- Office of Public Information
- Office of Real Estate Services
- Office of Transportation
- Office of Workforce Development

Once the strategies were drafted, the County held meetings and focus groups with representatives from the offices and departments that would ultimately have a role in implementing the strategies. From these conversations, the specific actions and steps were vetted. This step was critical to ensure that the strategies and actions have the buy-in of the staff who will be essential to their implementation. All departments and offices engaged in the process and mentioned in this Plan were given the opportunity to comment on written drafts of the document.

The County engaged external stakeholders as well. There are multiple groups in Howard County and the Baltimore metropolitan region that work on climate change issues. The County and these organizations collaborate and support each other as they work toward their own goals. Moreover, the County is ultimately charged with serving the citizens of Howard County, and their input informs County priorities.

The County held a public meeting at the beginning of the Climate Forward development process to solicit feedback from the public. The County also provided three opportunities for the public to provide written comments – once at the beginning of the process, once after the Preliminary Report was published in December 2022, and again when a draft of the full report was published in April 2023. The County collected and reviewed all comments and worked to incorporate them into Climate Forward wherever appropriate.

In addition, the County held several meetings with local nongovernmental organizations working on climate change issues and other key stakeholders that may be engaged in implementing some of the actions identified in the Plan.

Additional stakeholders included:

- Baltimore Gas & Electric
- Civic Works
- Community Action Council of Howard County
- Columbia Association Climate Change & Sustainability Advisory Committee
- Howard County Chamber of Commerce
- Howard County Economic Development Authority
- Howard County Environmental Sustainability Board
- Howard County Health Department
- Howard County Public School System
- Howard Soil Conservation District
- Workforce Development Board

The Office of Community Sustainability also conducted a survey of County citizens to understand more about their concerns surrounding climate change and where they have already felt impacts from climate-related events. More information about the survey and its results can be found in the Climate Change Preparedness Survey section of this report and in Appendix D.

Impacts of Climate Change

Climate change is shifting weather patterns with extreme weather events increasing in frequency and intensity. In 2019, the Baltimore Metropolitan Council (BMC) and the Baltimore Regional Transportation Board (BRTB) completed a study on historical changes in climate and projections for future changes in climate for all counties in the BMC region, including Howard County[1]. In general, the study found that the greater Baltimore region is getting hotter and is likely to experience more extreme weather events. Howard County is already experiencing documented impacts from climate change such as increasing temperatures, precipitation, and extreme weather events. The Columbia Association's Climate Vulnerability Assessment, which explored the impacts of climate change as they relate to extreme precipitation and flooding, extreme temperatures, and extreme weather, documented these impacts. [2]

Howard County: Moving Toward More Extremes

The sections below provide more detailed information about anticipated changes in heat, precipitation, extreme weather, and the associated impacts. The final section provides additional discussion on how impacts are not uniformly experienced throughout the County. Appendix C includes the full projections of changes in heat and precipitation from the BMC study.[3]

Note that *observed* values represent the average across the 20-year period 1986-2005. *Near-term* is the 20-year average over 2020-39, *mid-century* is the average over 2040-50, and *end-of-century* is the average over 2080-90. The BMC study used 20-year averages to account for the fact that there is natural variability from one year to the next, so no single year is representative of the overall climate.

Extreme Heat

Observed and Projected Changes

According to BMC study, Howard County will become notably warmer in the future. Notable projections include:

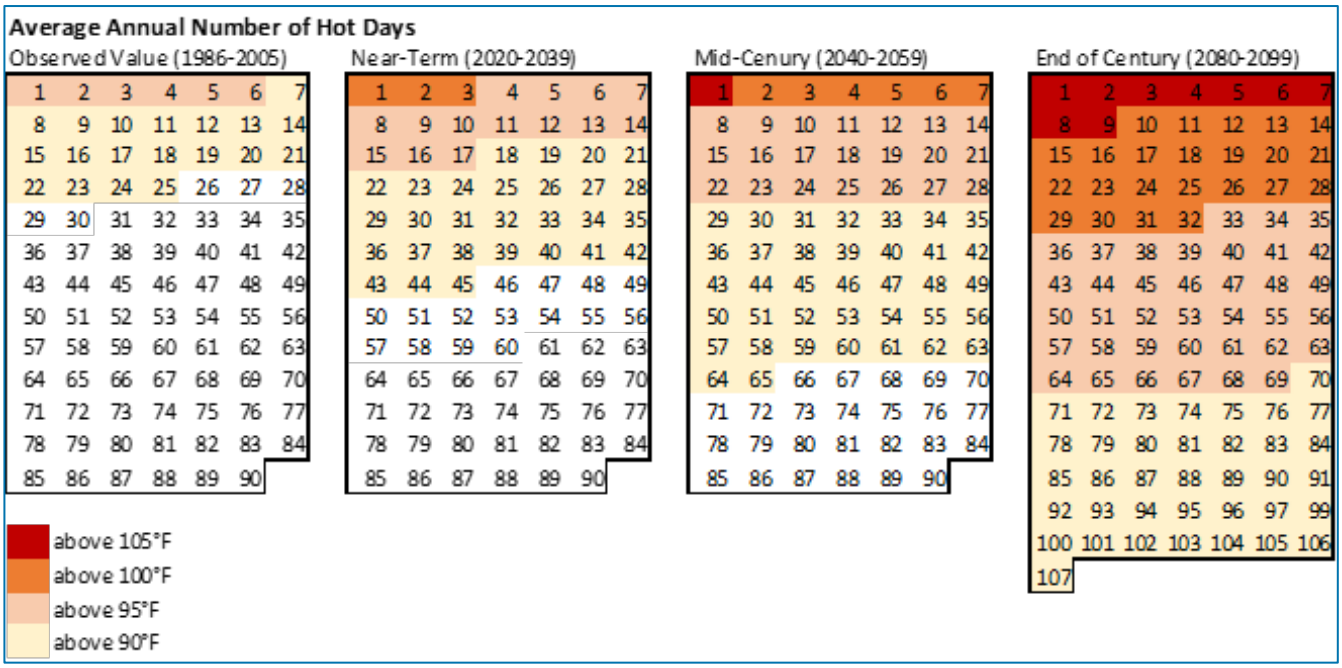
From the mid-1980s through the early 2000s, the number of heatwaves[4] averaged about 1 per year. By the middle of this century, Howard County will experience an average 6 heatwaves per year, and 18 by the end of the century.

During the observed timeframe in Figure 1, there was typically less than 14 days (two weeks) where nighttime temperatures stayed above 70°F. By the middle of the century, there could be 29 additional days (nearly a month) where nighttime temperatures stay above 70°F. By the end of this century, there will be 73 additional days (about two and a half more months) above 70°F compared to the observed timeframe. Warmer nights means that buildings and materials do not get the chance to cool off overnight, which means additional energy is required to cool buildings the next day.

The hottest day of the year in Howard County was, on average, around 97°F during the observed timeframe. By mid-century, the hottest day of the year could be around 103°F on average, and 108°F by the end of the century.

As shown in Figure 1 below, the number of days exceeding thresholds of 90°F, 95°F, 100°F, and 105°F are expected to increase substantially. For example, there used to be only a few days per year that were 95°F or hotter (6 days, on average, 1986-2005). By mid-century, Howard County could experience 28 days on average that are 95°F and above, and 69 days on average that are 95°F and above by the end of the century.

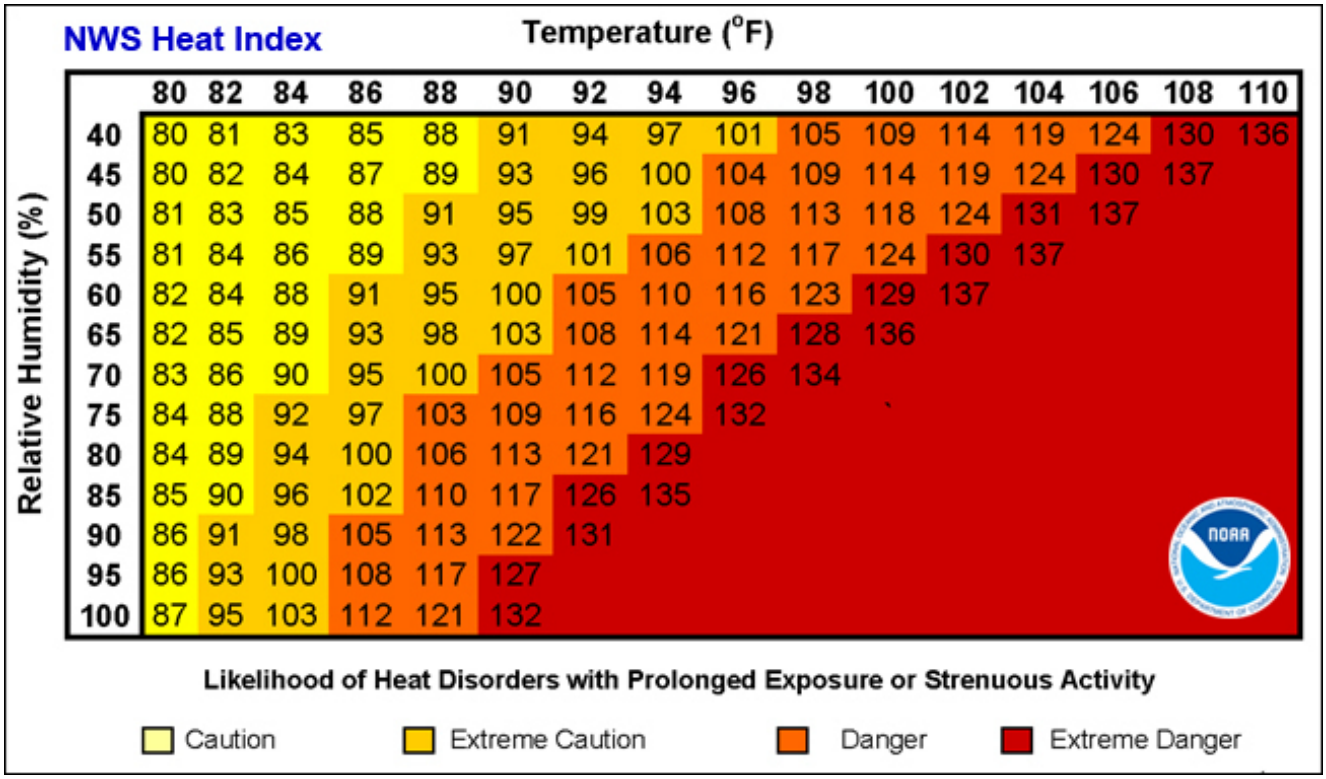
Figure 1: Average Annual Number of Hot Days



Average days where maximum temperatures exceed 90 °F, 95 °F, 100 °F, and 105 F from 1986 through the end of the century. Source: Developed using data from Baltimore Metropolitan Council

For perspective, the National Weather Service Heat Index (see Figure 2) considers 95°F to be potentially dangerous when humidity levels exceed around 45%—a level that is common in Howard County in the summer[5]. Therefore, these temperatures are not just uncomfortable, but are potentially dangerous. A heat index quantifies the temperature it feels to the human body when humidity and temperature is combined. According to the National Weather Service Index, a 96-degree Fahrenheit day with 45% relative humidity is considered dangerous and can make the human body feel like the temperature is 104 degrees Fahrenheit. It's important to note that the heat index values below are measured in shady conditions, and exposure to sunny conditions can alarmingly increase heat index values by 15°F. This combination of dry air temperature and humidity is sometimes called the wet-bulb temperature. The term gets its name from how it is measured. A wet cloth over the bulb of a thermometer cools the temperature, but if the humidity in the air is high, less evaporation occurs so the wet-bulb temperature is closer to the dry temperature. The wet-bulb temperature measures how well humans will be able to cool themselves through sweating. Typically, the body will regulate its own temperature when it gets too hot through the act of perspiring or sweating. Then, the sweat evaporates and cools the body down. When humidity levels are high, the rate of evaporation slows. The body cannot cool down as fast leading to heat stroke, exhaustion, and other heat-related illnesses[6].

Figure 2: National Weather Service Heat Index

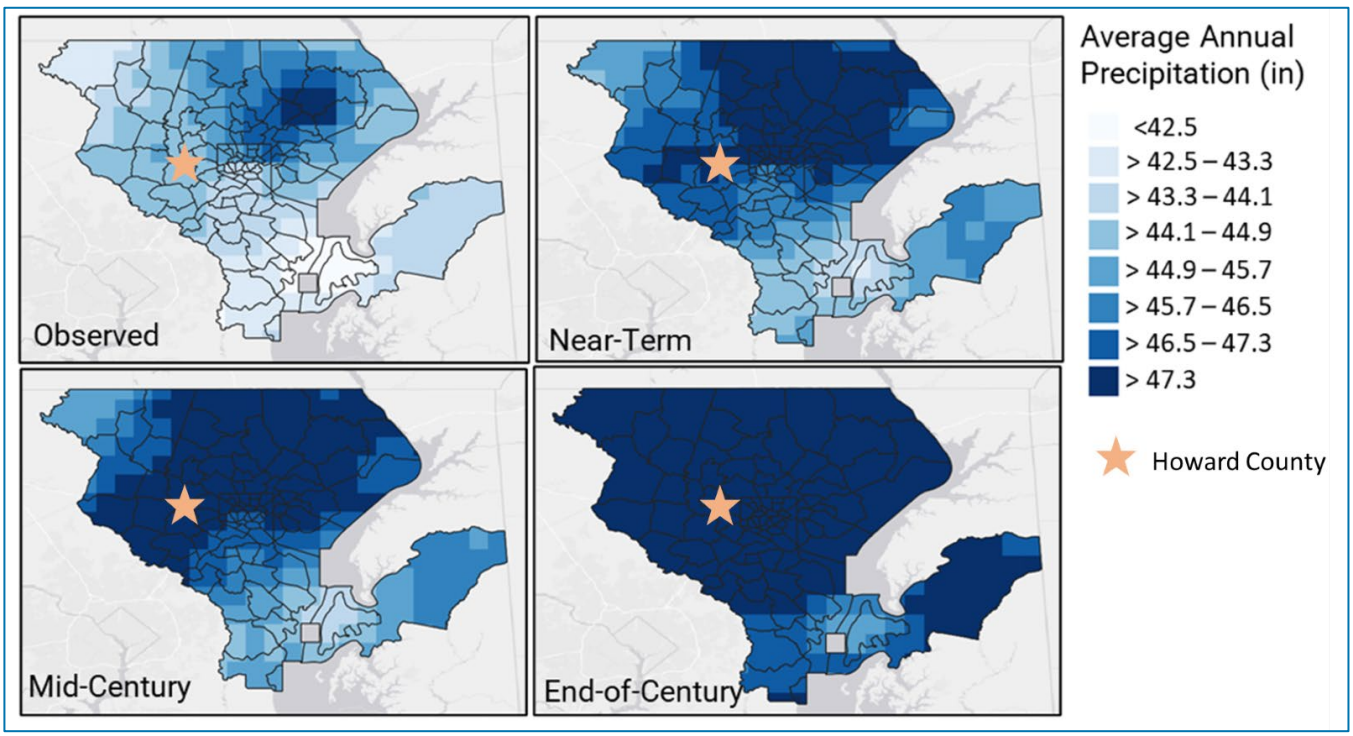


Source: National Weather Service, Heat Index chart. https://www.weather.gov/ama/heatindex

Precipitation

Climate change impacts surface temperatures causing them to rise, which in turn leads to an increase in evaporation. Following the simplified precipitation cycle, more evaporation leads to an increase in precipitation. Howard County is expected to experience more rain and snow over the coming decades. Figure 3 shows how average annual precipitation will change regionally from historical observations through near-term, mid-century, and end-of-century projections. Howard County, compared with other portions of the region, is statistically expected to see higher average annual precipitation. The County may see, on average, an additional 2.8 inches of precipitation per year by mid-century and an additional 5.1 inches by the end of the century. These increases in precipitation will not happen uniformly across the year. For example, the greatest increases are expected in the late winter and early spring, which may lead to more severe flooding during that time of year. While annual precipitation may only increase slightly, the precipitation is expected to come in shorter, more intense bursts. These precipitation events can be a particular strain on infrastructure and people. In contrast, more modest increases (or even decreases) in precipitation may occur in the late summer and early fall, which could lead to drought conditions.

Figure 3: Average Annual Precipitation Across the Region.

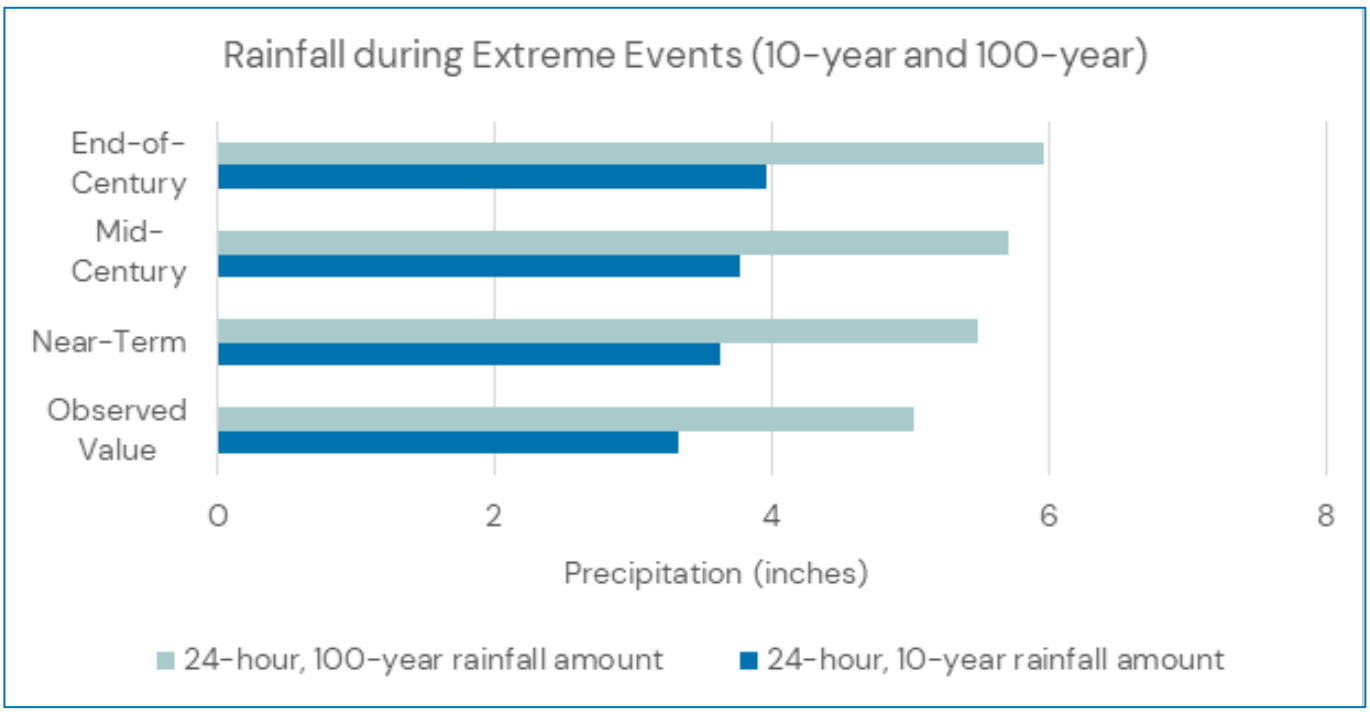


Average annual precipitation across the region. Projected values represent the 32-model ensemble mean for RCP 8.5. Source: BMC

Rainfall during extreme weather events is expected to increase significantly as well. During the observed timeframe (1986-2005), 1.5 inches of precipitation over a 24-hour period was considered an *extremely heavy precipitation* event.[7] By mid-century, an *extremely heavy precipitation* event could include an additional 0.2 inches of rainfall in 24 hours—a 13% increase. By the end of century, an extremely heavy precipitation event would include 0.3 more inches of precipitation, or a 20% increase. Although 0.2-0.3 inches may not sound significant, the combined run-off of the additional precipitation over a large area can overwhelm stormwater drainage systems and cause flooding.

Figure 4 shows how rainfall during extreme weather events is expected to increase for both 24-hour 10-year and 100-year events. Rainfall during these events is expected to increase between half of an inch to one inch by the end of the century.

Figure 4: Rainfall During Extreme Weather Events



Rainfall during extreme weather events for the Baltimore region. Projected values represent an RCP 8.5 emissions scenario. Source: BMC (2021)

A “100-year" flooding event is commonly misconstrued to sound like it only occurs once every 100 years. A more accurate description of a “100-year” flood event is that it has a 1% chance of occurring each year. Similarly, a “10-year" flood event has a 10% chance of occurring each year. Climate change is expected to cause more frequent and more severe flooding events. As flooding events are expected to increase in frequency, the recurrence interval and the terms for flood events may need to be reevaluated. For example, the chance of a “1000-year” event happening each year is 0.1%. In both 2016 and 2018, Old Ellicott City experienced a “1000-year” flood, a very severe flooding event. These catastrophic floods were responsible for fatalities, property damage, loads of debris, erosion, and business closures. [8,9]

More intense rainfall events can lead to more flooding. It is difficult to predict exactly where flooding will occur due to extreme rainfall events, as it depends on many factors. However, it is reasonable to expect that areas that already experience flooding will experience more frequent, and/or more severe, flooding events in the future. Flooding may also occur in areas that historically have not experienced flooding.

Other Extreme Weather Events

Scientists also predict more intense storms, which are associated with more wind damage and flooding. Climate change will lead to increasing frequency and intensity of extreme weather events across the entire Baltimore region. Storms will change in strength and volume due to warming atmospheric temperatures which provide additional energy to storms. For example, climate science trends are showing projected increases to the number of strong, Category 3 or higher, hurricanes through mid-century for the region.[10] These storms are accompanied by heavy rains, flooding, and severe winds that can damage infrastructure and cause power outages.

Derechos are another type of intense storm that could become more frequent. Derechos are a long band of windstorms that stretch across a large area of land with winds similar in strength to tornados or hurricanes. These storms produce heavy winds, thunderstorms, and rain. Derechos can cause “straight-line wind damage” since the winds of a derecho

move in one direction. In June of 2012, a severe derecho with winds exceeding 80 mph struck the Maryland area and hit many states on the way. This derecho caused widespread outages and damages. This storm caused millions of power outages reported by electricity delivery companies. These storms may become more frequent since the conditions that are needed to form a derecho will increase with the warming environment.[11]

Finally, although temperatures may increase overall, there may be more frequent winter cold snaps due to a cold air mass above the arctic, known as a polar vortex, weakening. A weakened polar vortex event pushes cold air into southern regions of the United States. Weakened polar vortex events and their impacts on the United States could be exacerbated due to climate change.[12, 13, 14, 15]

Climate Change Vulnerability in Howard County

The anticipated changes to Howard County's climate will have negative impacts on human health, natural systems, basic services, infrastructure, and other community systems. Based on research done for this Climate Action and Resiliency Plan, extreme heat and flooding were determined to be the most dangerous hazards, requiring the most resiliency action. Further research done by the Columbia Association's Climate Vulnerability Assessment focuses on these two hazards as well. Extreme heat and flooding can cause utility disruptions, occupational hazards, ecosystem changes, health complications, and more.

To understand how Howard County might be vulnerable to these changes in climate, the County relied primarily on the ICLEI Temperate Adaptation Planner tool, which assesses the vulnerability of various community systems to different climate hazards. This tool relied on subject matter expert input from various County departments and key external partners.

Temperate Study

The Temperate study was performed by Howard County's Office of Community Sustainability to assess the County's risk related to climate change. The Temperate tool utilizes a series of prompts to solicit subject matter expert input on the perceived impacts of cyclones, droughts, extreme heat, extreme winter conditions, flooding, and severe wind on community systems. Community systems included agriculture, business continuity, ecological function, emergency management, energy delivery, food supply, internet and communications, public health, public safety, quality of life, and tourism. Subject matter experts from internal and external stakeholders provided their best professional judgement on how severe the impacts of each climate hazard would be on each community system. They also provided their best professional judgement on how easily each community system can adapt and bounce back from each climate hazard. This information was used to determine the impact score, adaptive capacity, and adaptive need for each community system in relation to each hazard. County staff then prioritized the systems and hazards resulting in a high adaptive need. A high adaptive need, according to ICLEI, is the result of a high impact score and a low adaptive capacity score, meaning a community system would be impacted moderately or severely by the climate hazard and would have a hard time bouncing back from that impact. The methodology used for this Climate Vulnerability Assessment is further detailed in Appendix C.

As extreme heat and flooding were determined to be the hazards with the greatest potential impact on Howard County systems and sectors, Climate Forward focuses the Climate Vulnerability Assessment primarily on heat and flooding.

The following list contains the impacts of extreme heat on Howard County systems and sectors with a high adaptive need:

People and Communities

- Increased risk of heat-related illness and deaths, especially for babies, student athletes, seniors, the chronically ill, and individuals without air conditioning.

- Increased risk of asthma attacks and cardiovascular events on very hot days due to increased ozone and other air pollutants.
- Chronic stress and other negative impacts on mental health from prolonged heat and the inability to exercise outdoors.
- Increased violence often seen with prolonged heat stress, particularly in areas with low tree cover.
- Increased gastrointestinal illness from loss of refrigeration in power outage or lax food safety.
- Reduced ability to access outdoor attractions and dining.

Employment and Working Conditions

- Outdoor workers at risk of heat stroke and dehydration.
- Inadequate air conditioning or brownouts from an overloaded grid can reduce productivity and cause health impacts.

Infrastructure and Basic Services

- High temperatures reduce roadway integrity.
- Brownouts interfere with computational networks and information transfer between County offices, businesses, and residents.
- Schools with inadequate air conditioning may need to close.

Economic Impacts

- Reduced productivity of outdoor workers.
- Increased sick days during heat waves from heat stress, asthma, and cardiovascular events.
- Loss of patronage at outdoor businesses.
- Increased cost of damage to infrastructure as temperatures increase.
- Need to upgrade air conditioning systems (residential, commercial, and governmental) to maintain health of occupants.

Natural Systems

- Increased average temperature affects growth rates, survival, overwintering, and reproductive success of native species of animals and plants.
- Changes in temperature can affect species differently, destabilizing species interactions involving pollination, competition, and predation.
- Changes in temperatures may give invasive species a competitive edge over native species.
- Declined water quality and dissolved oxygen in warmer ponds, streams, and wetlands, while pathogens increase. This harms freshwater animals and plants.
- Algal blooms can increase to dangerous levels as ponds and streams warm.
- Length and severity of fire season increase with temperature.

Agriculture and Gardening

- Rising summer temperatures increase risk of drought stress in plants, given that additional summer rain not expected.
- Effective pollination in crops like corn and tomatoes is reduced by high temperatures; flowers and fruit can abort.
- High temperatures reduce growth and fertility in domesticated animals and lower milk production in dairy cattle.
- Insect pest populations can spike; some insects may add another generation to yearly cycle.
- Some insect pests may gain the ability to overwinter in Maryland, increasing their impact.
- Insect pollinators can get out of sync with their plants and control of insect pests by natural enemies can fail when species respond differently to warming.

- Warmer winters can cause plants to break dormancy too early and be damaged by late spring frosts.

The following list contains the impacts of increased storms and flooding on Howard County systems and sectors with a high adaptive need:

People and Communities

- Increased risk of injury or death in flooded areas due to drowning, electrocution, or dangerous debris.
- Water damage to homes can produce long term health risks from mold.
- Power outages from storms that shut down air conditioning and refrigeration amplify heat stress.
- People may not be able to access medical care or obtain medications.
- Transport of pathogens in floodwaters increases illness through direct contact or contaminated food.
- Increased risk of disease transmission from mosquitoes when areas of still water remain after flooding.
- Potable water supplies can become contaminated by floodwaters.

Employment and Working Conditions

- Flood damage to commercial buildings can cause inability to access or open businesses.
- Rescue workers at risk in stormy or flooded conditions from flying debris and chemicals or pathogens in floodwater.

Infrastructure and Basic Services

- Flood damage to roads, bridge supports, and stormwater management systems can be severe.
- Power outages interfere with computational networks and information transfer between County offices and residents.
- Significant delays in normal operations and emergency response during flood damage and cleanup.
- Electric service restoration can be delayed in areas with significant flooding.
- Hospitals and medical centers can be damaged or inaccessible.
- Flooding can overwhelm water treatment plants, leading to discharge of contaminated water into streams or the Bay.

Economic Impacts

- Flooding can keep customers from accessing businesses, reducing sales.
- Cost of disaster recovery for businesses and County is increasing as climate change progresses.
- Cost of storm-related damage to infrastructure for businesses and County are increasing.
- Cost of upgrading stormwater management systems rises as damage increases.

Natural Systems

- Heavy rains contaminate waterways with increased litter and pollutants.
- Erosion from stormwater increases sedimentation in surface waters, causing negative impacts to plants, invertebrates, and fish.
- Increased runoff of agricultural chemicals and fertilizer during floods damage life in streams, rivers, and the Bay.

Agriculture and Gardening

- Flooding rains can interrupt planting or harvesting.
- Flooding increases erosion and loss of topsoil.
- Heavy rains may cause damage to crops from waterlogging.
- Flooding washes pollutants, litter, and toxins into waterways.
- Flooding and runoff can wash more agricultural and lawn chemicals into streams, rivers, and the Chesapeake Bay.

Differential Impacts

Overall, the climate in Howard County is getting hotter, with more frequent and intense extreme weather events. Notably, impacts from climate change are not felt uniformly across the County, in terms of both geography and populations. Some areas are more prone to flooding events, and some areas are expected to experience higher temperature increases than others due to local characteristics such as the urban heat island effect.

Although climate change impacts will be felt across all of Howard County, these impacts will not affect everyone equally. Extreme weather, heat, and flooding have the greatest potential to impact those who hold physiological, economic, and social characteristics that make them more vulnerable to climate.

Underserved populations may be less resilient to extreme weather. For example, they may be less able to absorb increased utility costs, may live in buildings with less weatherization to help keep homes comfortable, may lack air-conditioning, may be less able to afford amenities that make heat more tolerable (e.g., air conditioning, swimming pool access), and may have fewer transportation options to buildings, shaded parks, and other places that may offer relief. They may be less able to absorb the financial impacts of damage to homes and property or have fewer transportation options when a given roadway is temporarily impassible from a flood. The Baltimore Metropolitan Council, among many other agencies and organizations, has identified several characteristics that qualify individuals as being at greater risk to climate impacts.[16] These characteristics are shown in Table 1.

Table 1: Vulnerability Characteristics

Vulnerability Characteristic	How Does this Increase Vulnerability to Climate Change Impacts?
Poverty	A lack of financial resources is correlated with lower abilities to gather supplies like food, water, and back-up generation to withstand natural disasters and climate impacts.
Non-Hispanic, Non-White, Hispanic	Individuals who classify as a race or ethnicity other than white are statistically more vulnerable to climate change impacts due to lower levels of access to community resources.
Limited English Proficiency	In general, communications materials and messaging are predominately presented in English. Individuals who cannot speak, read, or write English, experience limited access of resources.
Disabled	Individuals with mobility issues or impairments cannot access resources in the same way that non-disabled persons can, thus limiting their ability to deal with climate impacts.
Elderly	Elderly individuals are susceptible to extreme heat and often have impairments or mobility issues that prevent them from accessing resources.

Howard County used the Vulnerable Populations Index to help better understand potential differences in vulnerabilities of communities within the County. The Columbia Association's Climate Vulnerability Assessment was also utilized for this purpose.

A Closer Look: Heat and Flooding Vulnerabilities

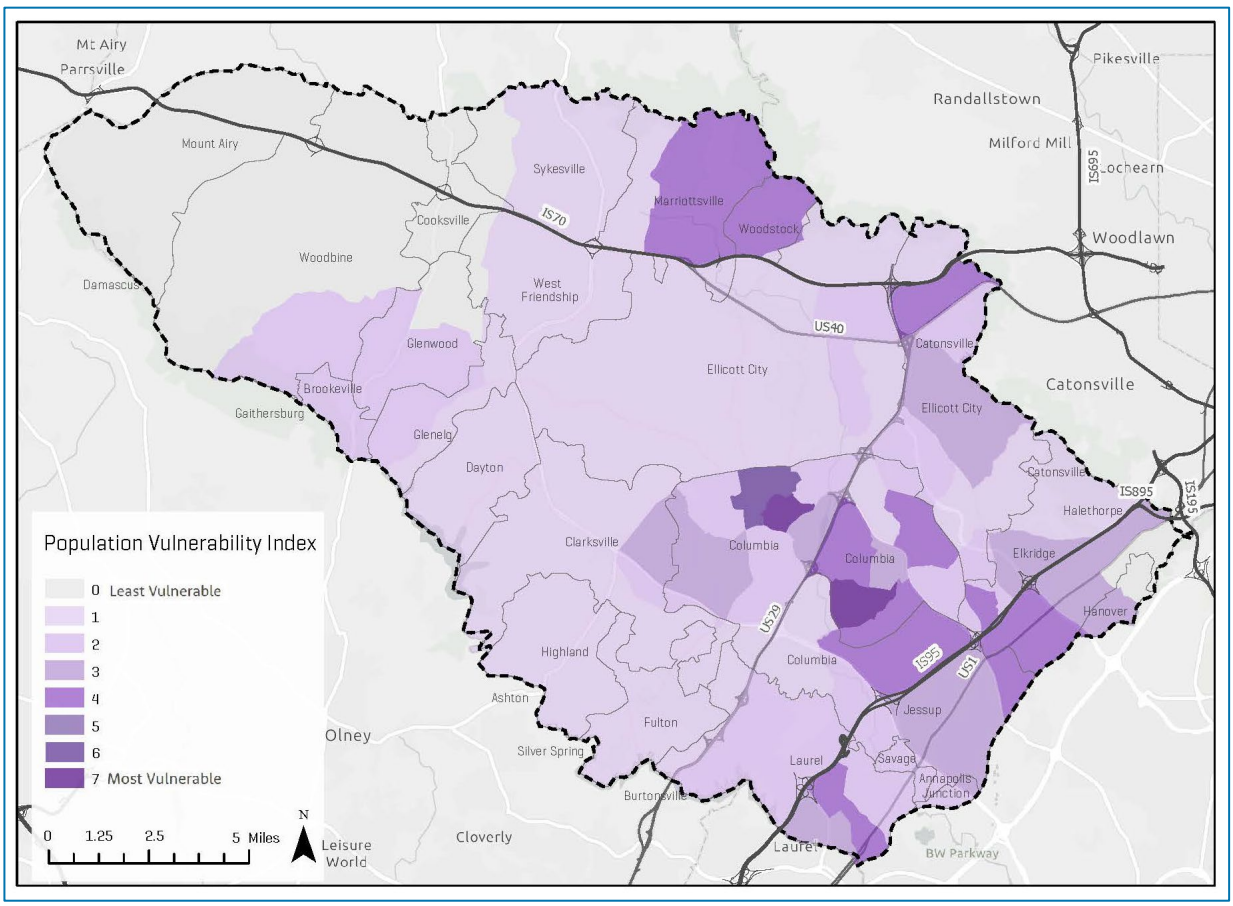
Flooding and heat are projected to increase in frequency and magnitude above historical baseline levels and will have significant impacts on people, infrastructure, and the environment. The present impacts of extreme heat across Howard County are represented in this assessment using land surface temperatures from available meteorological data sets. The present impacts of flooding across Howard County are represented in this assessment using FEMA 100-year and 500-year floodplain extents. To focus this climate vulnerability assessment further, the study team mapped both heat and flooding across Howard County to better understand how impacts will be felt across the County.

Vulnerabilities to Extreme Heat

Heat is anticipated to increase significantly in the future in Howard County, but the impacts will not be uniform across the County. Therefore, Howard County completed a spatial analysis that considered spatial variation in temperatures, alongside variations in population vulnerabilities.

The assessment first considered relative vulnerabilities of different communities, drawing on the Baltimore Metropolitan Council's Vulnerable Populations Index for each Census tract in Howard County. The BMC Vulnerable Populations Index considers the following characteristics that may make a community more vulnerable: poverty; non-Hispanic, non-white; Hispanic, Limited English Proficiency (LEP), disabled, elderly, and carless. Although this Index does not directly reflect vulnerability to heat, these characteristics are ones that could indicate either health or socio-economic situations that would make someone more vulnerable to extreme heat. For example, the elderly tends to be more sensitive to extreme temperatures. Poverty may be correlated with residences lacking sufficient cooling capabilities. Being carless may make it more difficult to travel without being exposed to high temperatures. Figure 5 shows the Population Vulnerability Index by Census tract.

Figure 5: Population Vulnerability Index



The assessment next considered geographic variations in heat. In this assessment, extreme heat across Howard County is represented by using land surface temperatures from meteorological data sets during a previous extreme heat event in Howard County which occurred on May 13, 2021. Temperatures were not uniform across the County due to variations in local characteristics such as the urban heat island effect. This index indicates that the eastern part of the County may experience hotter temperatures than the western part during extreme heat events.

Howard County combined this information on variations in heat and populations to create a Heat Vulnerability Index (Figure 6). The heat vulnerability index effectively surmises the vulnerability of that Census tract to increasingly extreme heat events due to the characteristics of that Census tract's population, with darker areas of the map representing a higher vulnerability to heat and climate change impacts. Heat vulnerability across Howard County is most pronounced among southeastern portions of the County, which is primarily due to a greater portion of land area being covered by buildings, infrastructure assets, impervious surfaces, and a lack of tree cover. Jessup, Hanover, and Elkridge have a higher heat vulnerability than other areas. The Wilde Lake Village Center has the highest heat vulnerability in the County. Promoting more tree cover, shade structures, cooling surfaces, and cooling centers in these areas can help those who are more vulnerable to extreme heat.

Figure 6: Heat Vulnerability Index

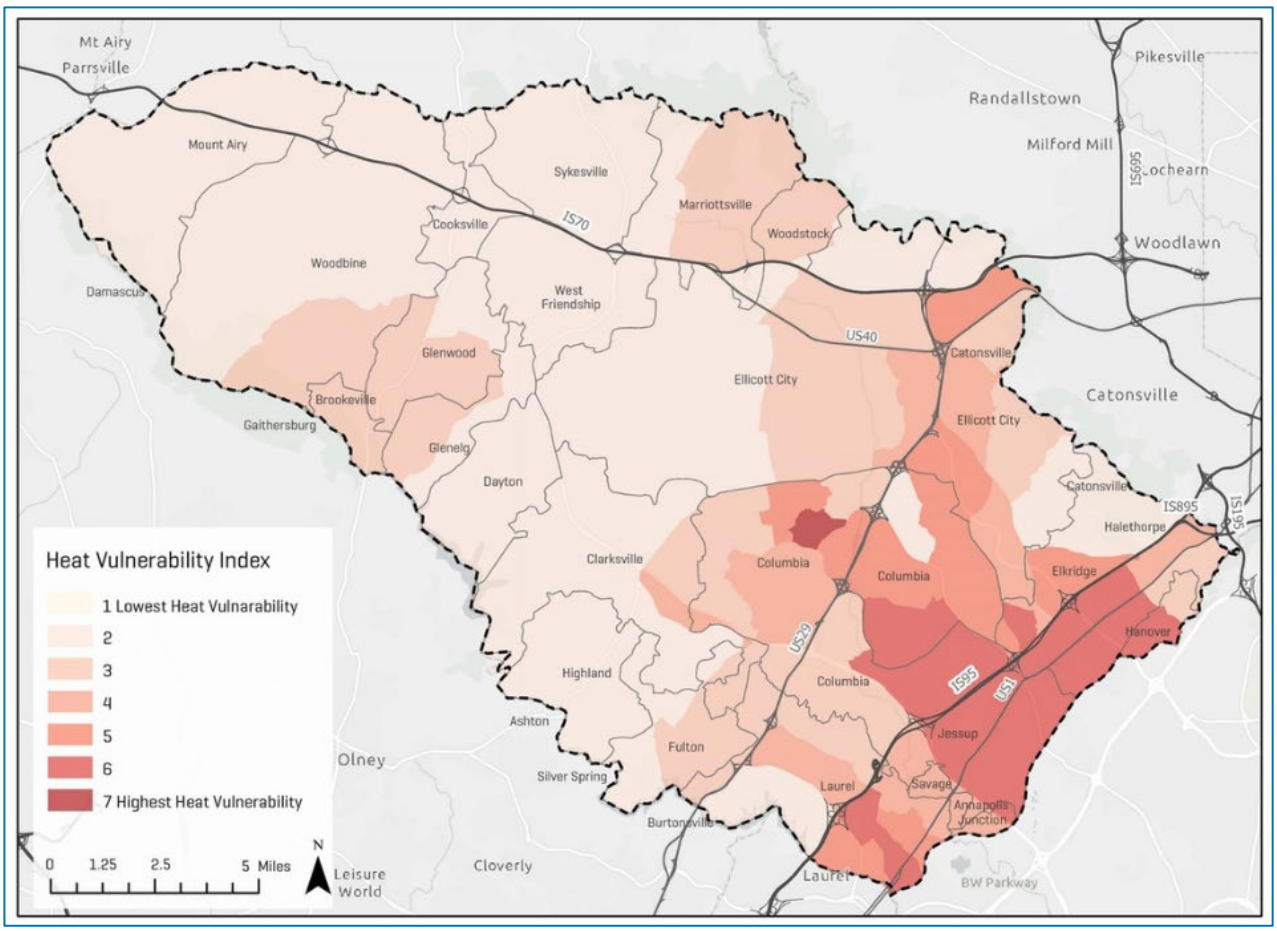


Figure 7 adds the location of the County's current emergency cooling centers to the Heat Vulnerability Index map to show the locations of these centers relative to heat vulnerability. This information can help Howard County assess the need for additional emergency cooling centers. For example, the far eastern section of Howard County has a high overlap of urban heat islands and under-resourced populations, which may indicate a need for additional cooling centers in the area.

Figure 7: Heat Vulnerability Index and Cooling Center Locations

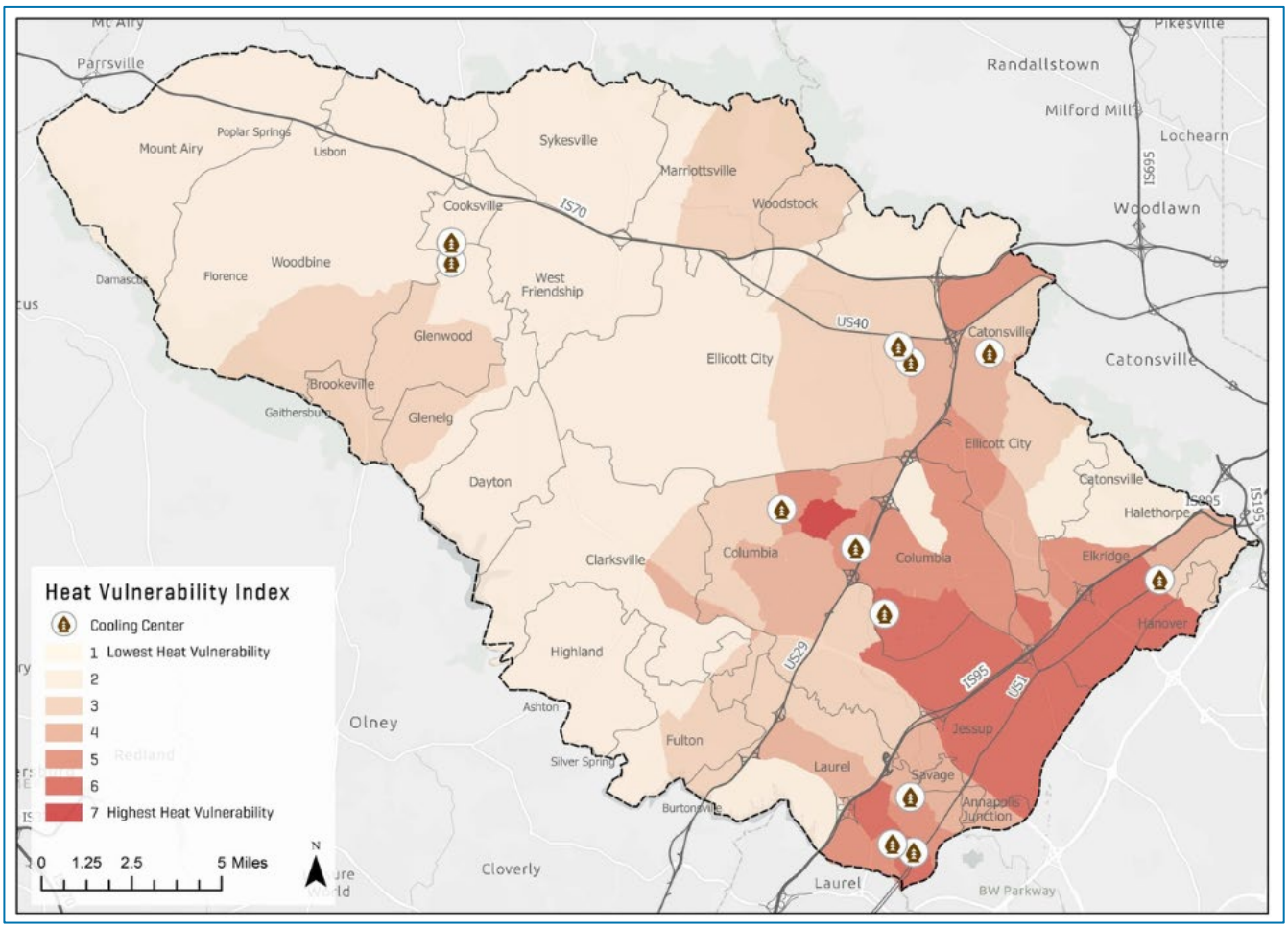


Figure 8 shows Howard County Tree Canopy data overlayed with the heat vulnerability index. Howard County should focus tree planting efforts on areas with higher heat vulnerability and less tree canopy. For example, southeastern Howard County has a high heat vulnerability and areas where tree canopy is lacking. Figure 9 shows tree canopy in an Elkridge neighborhood. Zooming in on interactive versions of these maps can help County staff identify neighborhoods that would benefit the most from tree plantings because they have a high heat vulnerability and low tree canopy.

Figure 8: Heat Vulnerability Index and Howard County Tree Canopy

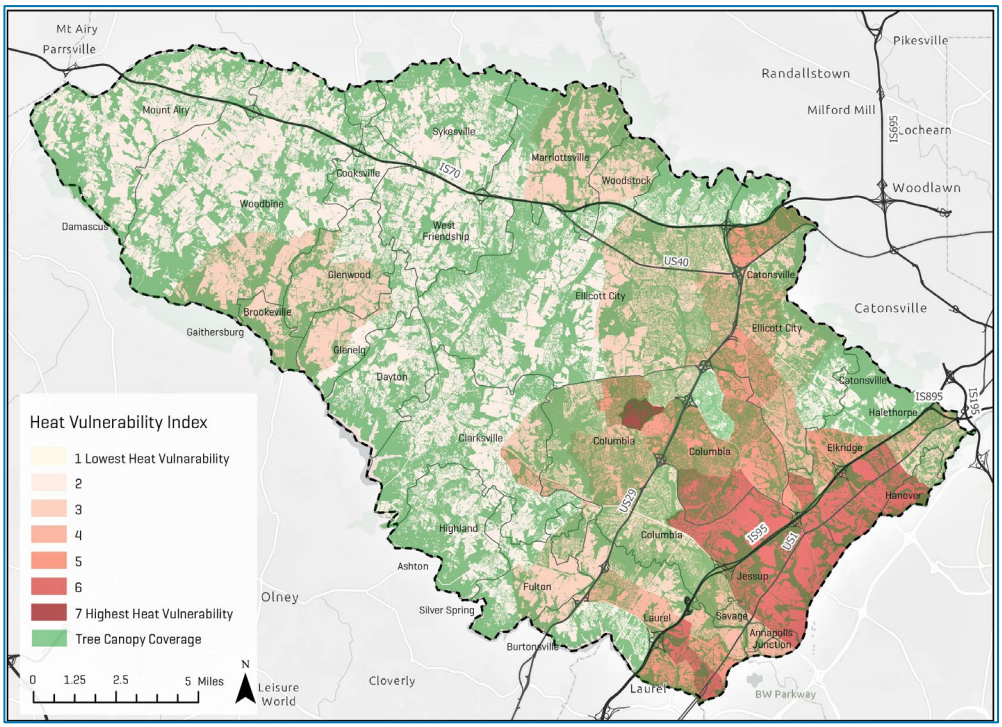
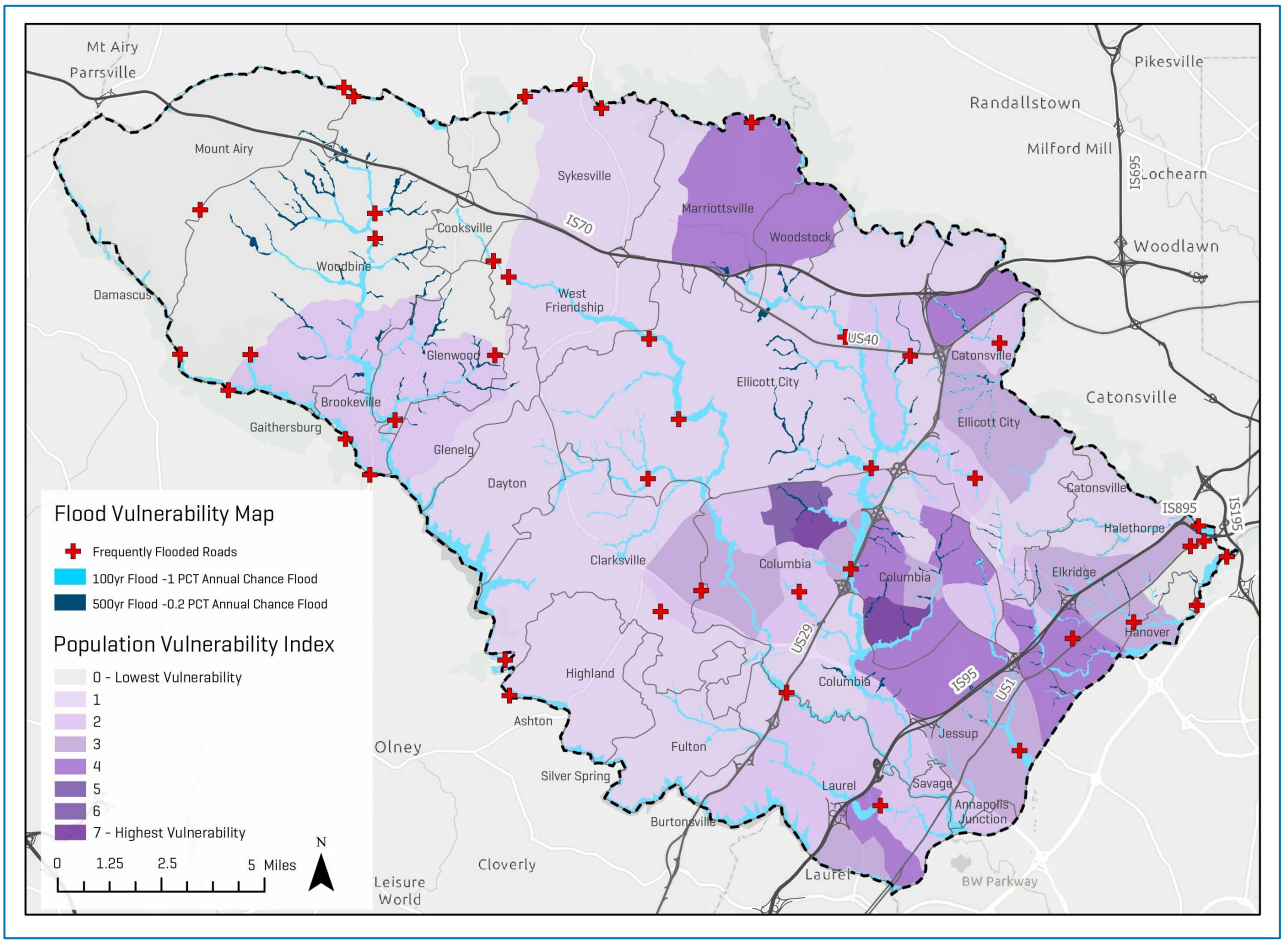


Figure 9: Tree Canopy Cover in an Elkridge Neighborhood

Vulnerabilities to Flooding

To better understand areas and communities at potential risk for flooding, Howard County has compiled spatial layers of the Federal Emergency Management Agency (FEMA) 100-year and 500-year flood zones, locations of frequently flooded roads, locations of County and critical facilities, and the BMC Vulnerable Populations Index. This information will help the County make informed decisions on where to prioritize investments to increase resiliency to flooding. To illustrate this information, Figure 10 below shows the flood zones, locations of frequently flooded roads, and the Vulnerable Populations Index. As this figure shows, there are flood zones and frequently flooded roadways throughout the County, including in communities scoring higher on the Vulnerable Populations Index.

Figure 10: Flood Zones, Vulnerable Populations Index, and Frequently Flooded Roads



Howard County faces significant flooding concerns within the 100-year and 500-year floodplains throughout the County, and particularly in and around central and eastern portions of Howard County. Importantly, there are several critical facilities— such as Howard County's K-12 schools, fire stations, police stations— that are in or near floodplains. In addition to flooding concerns at these critical community resources and facilities, there are several roadways experiencing frequent flooding, which will further jeopardize access to and from these critical facilities. Columbia Association's Climate Vulnerability Assessment revealed that high risk assets such as bridges and tot lots are in Harper's Choice, Hickory Ridge, Kings Contrivance, Long Reach, and Owen Brown[17]. Areas showing higher vulnerability to climate change impacts that overlap with FEMA 100 and 500-year floodplains may be priority areas for the implementation of flood reduction and stormwater management strategies and actions.

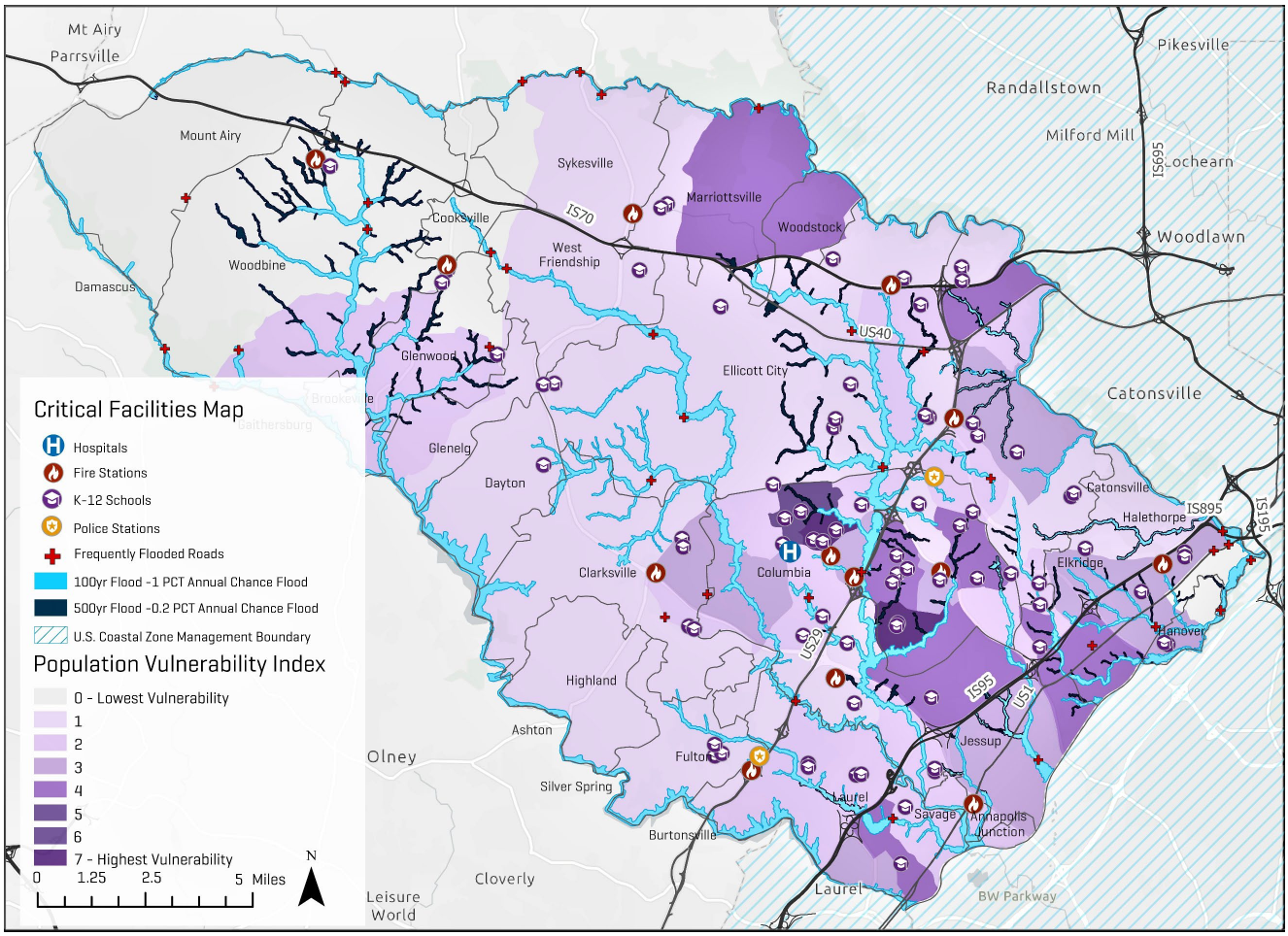
To help understand which important facilities could be affected by flooding in the future, Howard County conducted a spatial analysis to determine how close key facilities are to the current FEMA 100-year and 500-year flood zones. Table 2 summarizes some of the key facilities that are less than 1,000 feet from the flood zones. These facilities will not

necessarily be exposed to flooding, as local topography and hydrology will influence actual flooding. However, this assessment provides a general idea of the types of facilities that could be affected by flooding, either by being directly flooded or having key access roads flooded. Figure 11 shows the flood zones, critical facilities, and vulnerable populations index on a map.

Table 2: Important Facilities Near Flood Zones

Facility Type	# of Facilities <1,000 feet from the 100-year flood zone	# of Facilities <1,000 feet from the 500-year flood zone
Police Stations	2	2
Public K-12 schools	16	18
Fire Stations	3	3
Hospitals	0	0
State Facilities	9	3

Figure 11: Flood Zones, Vulnerable Populations Index, and Critical Facilities

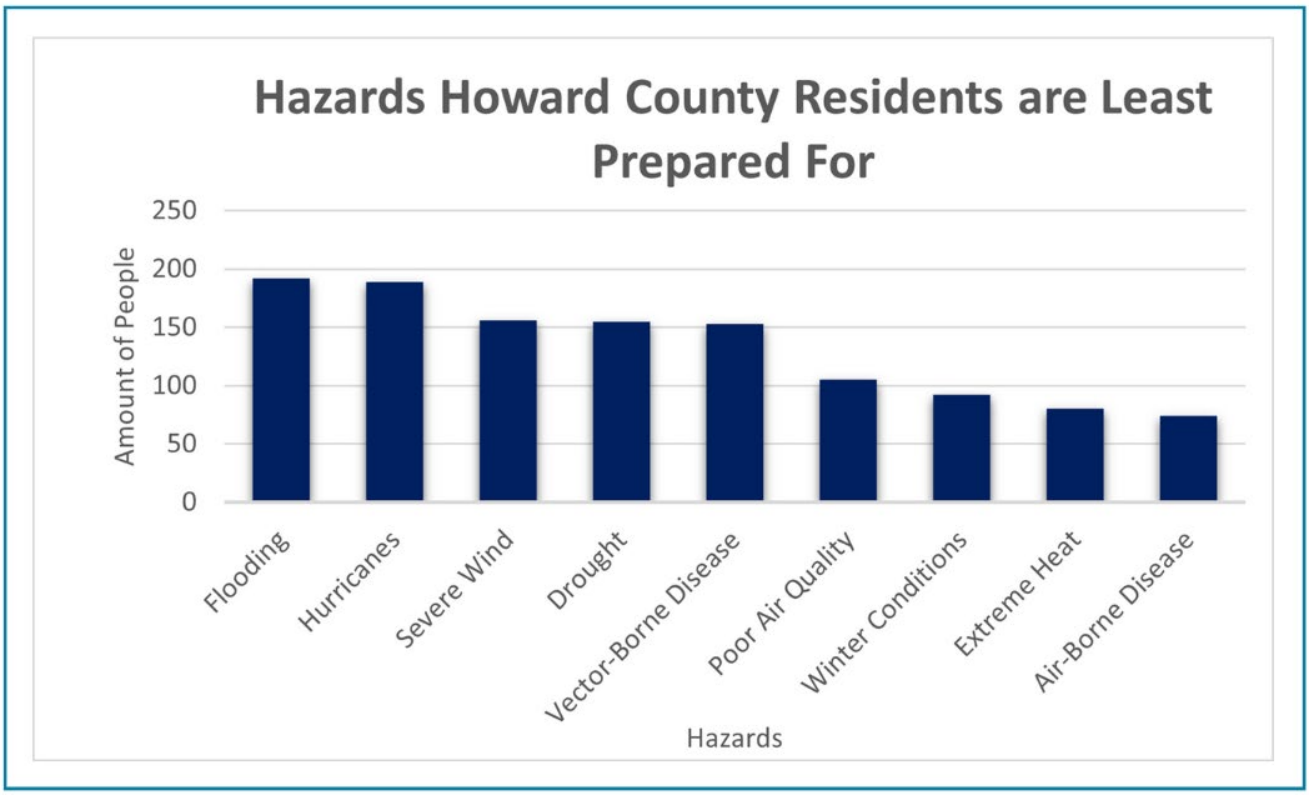


Climate Change Preparedness Survey

The 2022 Climate Change Preparedness Survey, administered by Howard County's Office of Community Sustainability, was designed to get feedback from Howard County residents on how well they feel they are prepared for climate hazards that are expected to increase in intensity and/or frequency, what they need to feel better prepared, and what climate related hazards they have experienced. The survey was primarily distributed to underserved communities, such as individuals aged 65 and older, individuals with low or moderate income, people of color, and individuals with disability/access and functional needs.

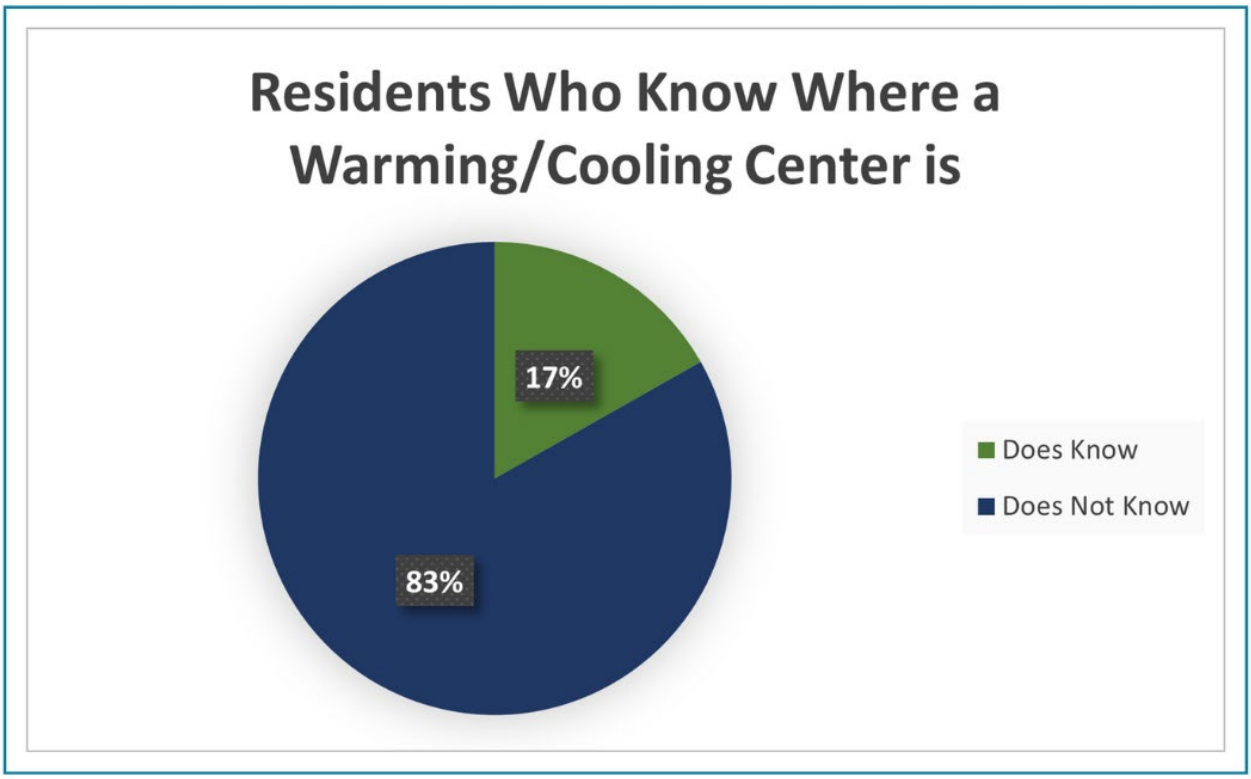
The results showed that citizens have already experienced weather-related disruptions in power and do not feel adequately prepared for flooding and major storm events (Figure 12). Citizens also expressed concern about how increasing temperatures could affect air quality and their health. The results also indicated communication gaps and suggested that community members are not aware of available resources and services, what heating/cooling centers are or where they are located (Figure 13), and where they can find information related to emergency preparedness. A total of 434 residents took the survey and their feedback played a crucial part in shaping the proposed resiliency strategies and actions to improve emergency preparedness.

Figure 12: Hazards Howard County Residents Feel Least Prepared For



Source: Howard County Climate Change Emergency Preparedness Survey

Figure 13: Howard County Residents Who Know the Location of a Heating/Cooling Center



Source: Howard County Climate Change Emergency Preparedness Survey

Other key findings from the Climate Change Emergency Preparedness Survey included:

- The four most common experiences faced by survey respondent in the last two years were: power outages, home or property damages after a storm, home or property damages from flooding and heavy rains, and no air conditioning in the house when needed.
- Nearly a quarter of respondents do not feel prepared if an emergency event were to occur.
- Nearly half of respondents feel generally that the community has resources and services to help them during an emergency event.
- Howard County residents listed airborne diseases as the number one hazard experienced in the last two years, most likely from Covid-19, followed by poor air quality and heat-related illnesses.

How Howard County Contributes to Climate Change

As a foundational element of this Climate Action Plan, Howard County developed a new greenhouse gas (GHG) emissions inventory and analyzed changes in current GHG emissions from its 2005 baseline. The County also estimated future GHG emissions through 2045 based on projected changes in the electricity grid, expected increases in the proportion of electric vehicles on the road, and anticipated population growth within the County. This information helps shape the strategies and action proposed to mitigate GHG emissions and to sequester carbon.

Overview of Greenhouse Gas Emissions Inventory Process

Howard County developed a community wide GHG emissions inventory based on 2019 data to identify current sources and drivers of emissions. The 2019 data set was the most recent and most complete data set that did not include anomalies in emissions caused by the COVID-19 pandemic. This inventory informed the GHG emissions reduction

strategies presented in this plan and provides a baseline for the County to track progress over time. Specifically, the GHG inventory estimates emissions from the following sectors:

Transportation (vehicle miles traveled) by on-road passenger vehicles, freight and service vehicles and transit vehicles operating within the County.

Built Environment (electricity use and stationary combustion of fossil fuels such as natural gas by residents, businesses, and government operations; refrigerant leakage from refrigeration and air conditioning equipment; and fugitive emissions from industrial oil and gas operations within the County. Fugitive emissions are emissions that escape from tanks, pipelines, and other pressurized equipment during typical operation.)

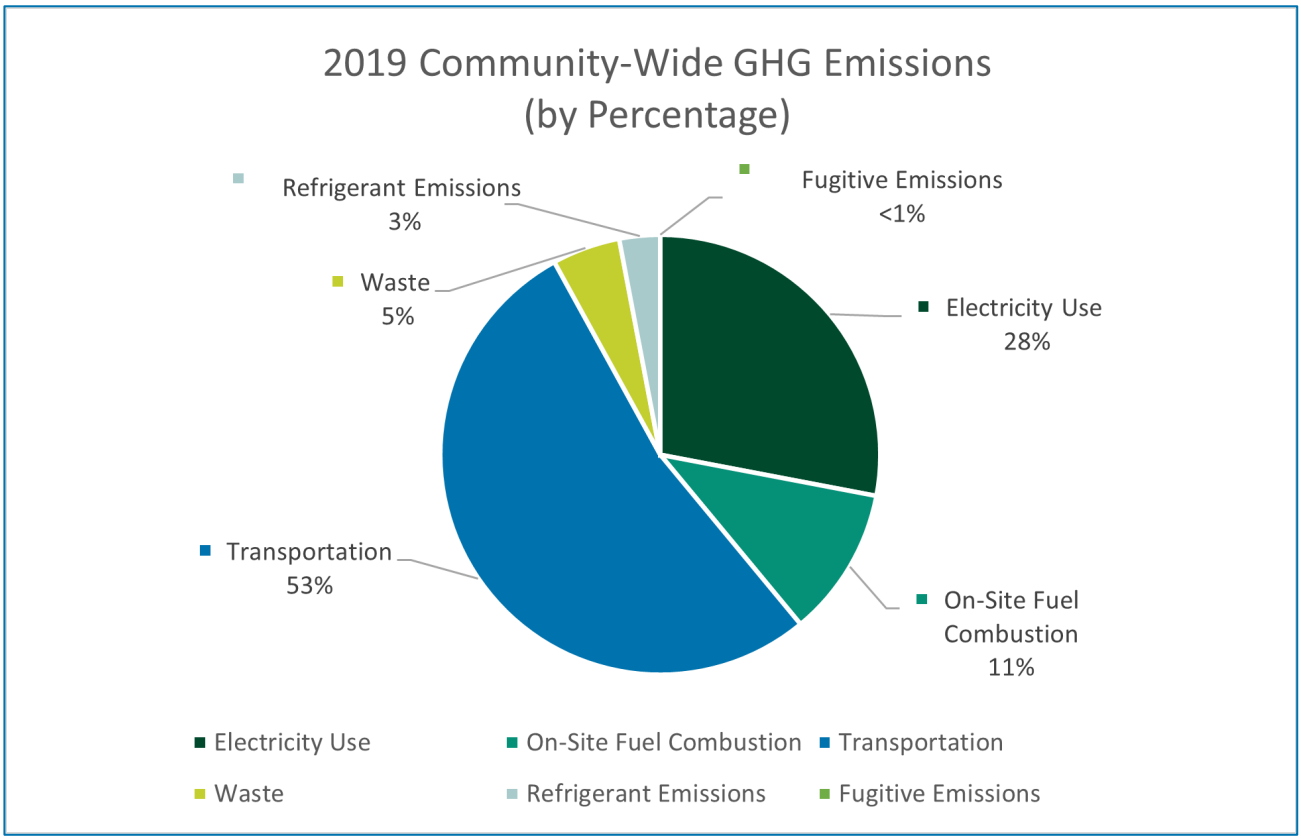
Solid Waste (waste disposal and composting) at the Alpha Ridge landfill and the disposal of waste generated by the community and landfilled outside of the County.

Howard County prepared this GHG inventory using the ICLEI ClearPath tool, which follows the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (developed by ICLEI). More details about the GHG Emissions Inventory, source data, and methods used to estimate or model emissions, are provided in Appendix E.

Current GHG Conditions in Howard County

In 2019, Howard County generated 3.9 million metric tons of carbon dioxide equivalent (MT CO_2e) community-wide, including the public and private sectors. Over half of these emissions were from the transportation sector (53%). Other emissions sources include electricity use at 28%, on-site fuel combustion at 11%, waste disposal (including waste generated in Howard County but disposed of outside of the County) at 5%, refrigerant emissions at 3%, and fugitive emissions such as leaks in fuel transportation pipes at less than 1%. Figure 14 shows the breakdown of emissions in 2019.

Figure 14: Howard County's 2019 Community-Wide GHG Emissions

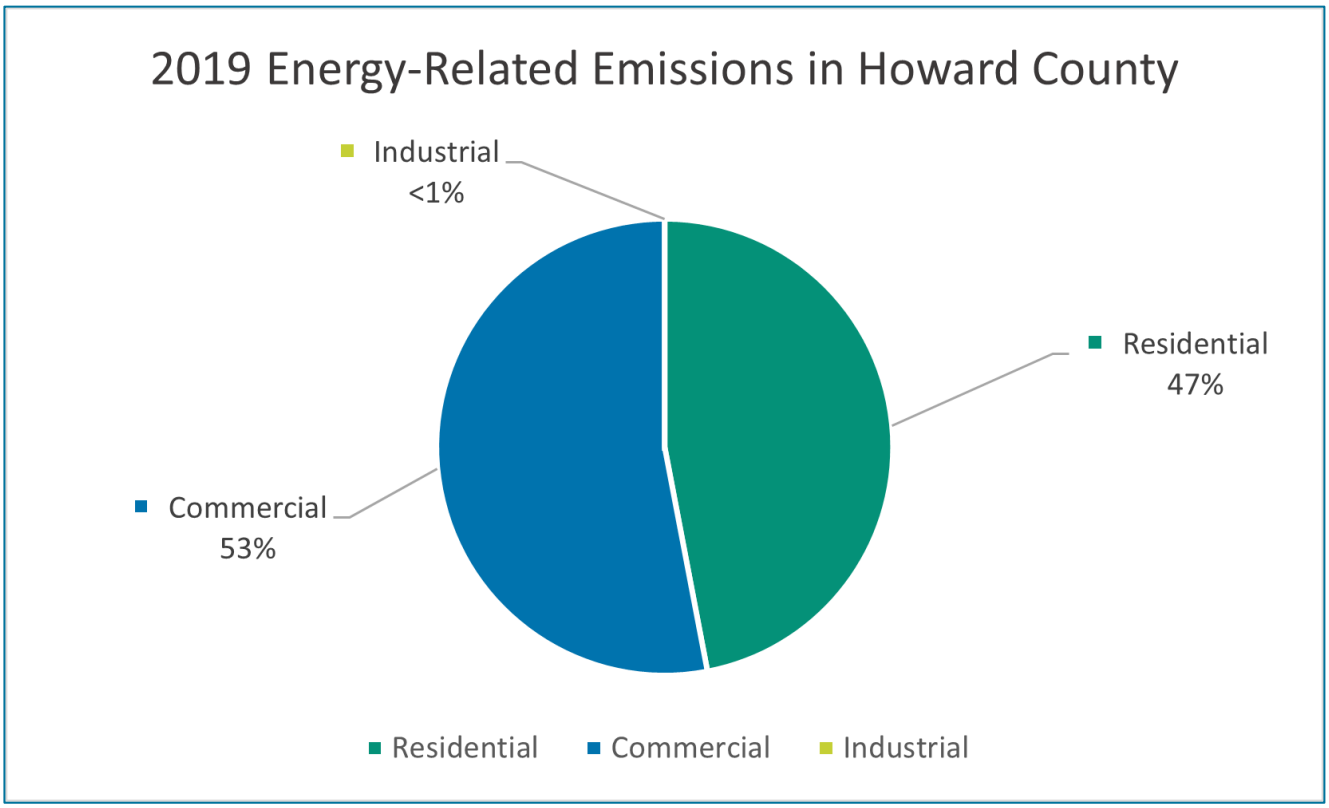


Built Environment

The built environment consists of man-made or modified structures that provide people with living, working, and recreational spaces. The built environment category includes emissions from the combustion of fossil fuels for energy and heat generation in buildings, as well as leakage from refrigeration equipment. Energy use includes on-site stationary fuel use (for example, natural gas boilers) and the use of purchased electricity in facilities. The Built Environment sources from Figure 14 above include electricity use (28% total emissions), on-site fuel combustion (11% total emissions) and refrigerant emissions (3% of total emissions). Adding these together, the built environment accounts for 42% of total emissions in Howard County in 2019.

The energy use portion of emissions in the County further can be allocated between residential (single and multi-family homes), commercial (businesses), and industrial end-users. Figure 15 shows a breakdown of energy sector emissions from Howard County in 2019 across commercial, residential, and industrial end-users. Emissions are close to evenly split between commercial and residential sectors, with 53% and 47% respectively. Industrial end users represent less than 1% of total electricity use. This includes emissions from both purchased electricity and on-site fuel combustion but does not include refrigerant leaks.

Figure 15: 2019 Energy-Related Emissions in Howard County



Refrigerant leaks, which account for 3% of Howard County's emissions, can be a significant contributor to climate change, as these chemicals typically have high global warming potentials (GWPs). These emissions occur as the charge in refrigeration and air conditioning (AC) equipment—such as window AC or commercial retail refrigeration units—leaks, either through normal operations or during maintenance. Currently, most equipment uses hydrofluorocarbons (HFCs) as a refrigerant, which can be more than 10,000 times as potent a greenhouse gas as CO_2.

Transportation and Other Mobile Sources

The combustion of fossil fuels in on-road transportation, including travel by passenger vehicles, freight and service vehicles, and transit vehicles, is the largest source of emissions in Howard County. Most vehicles in Howard County (79%)

are passenger cars.[18] Within the County's boundaries, on-road vehicles traveled about 4,362 million miles in 2019—the fifth highest County in state of Maryland. Of this, in 2019 1,462 million miles (33%) were pass-through miles on interstates including I-95.

Solid Waste

The Alpha Ridge Landfill is the only open landfill in Howard County. About 6% of the County's municipal solid waste is disposed at this landfill, with the majority sent out-of-jurisdiction. The County also operates a composting operation at the Alpha Ridge Landfill, which processes organic waste from the County's Green Bin program.

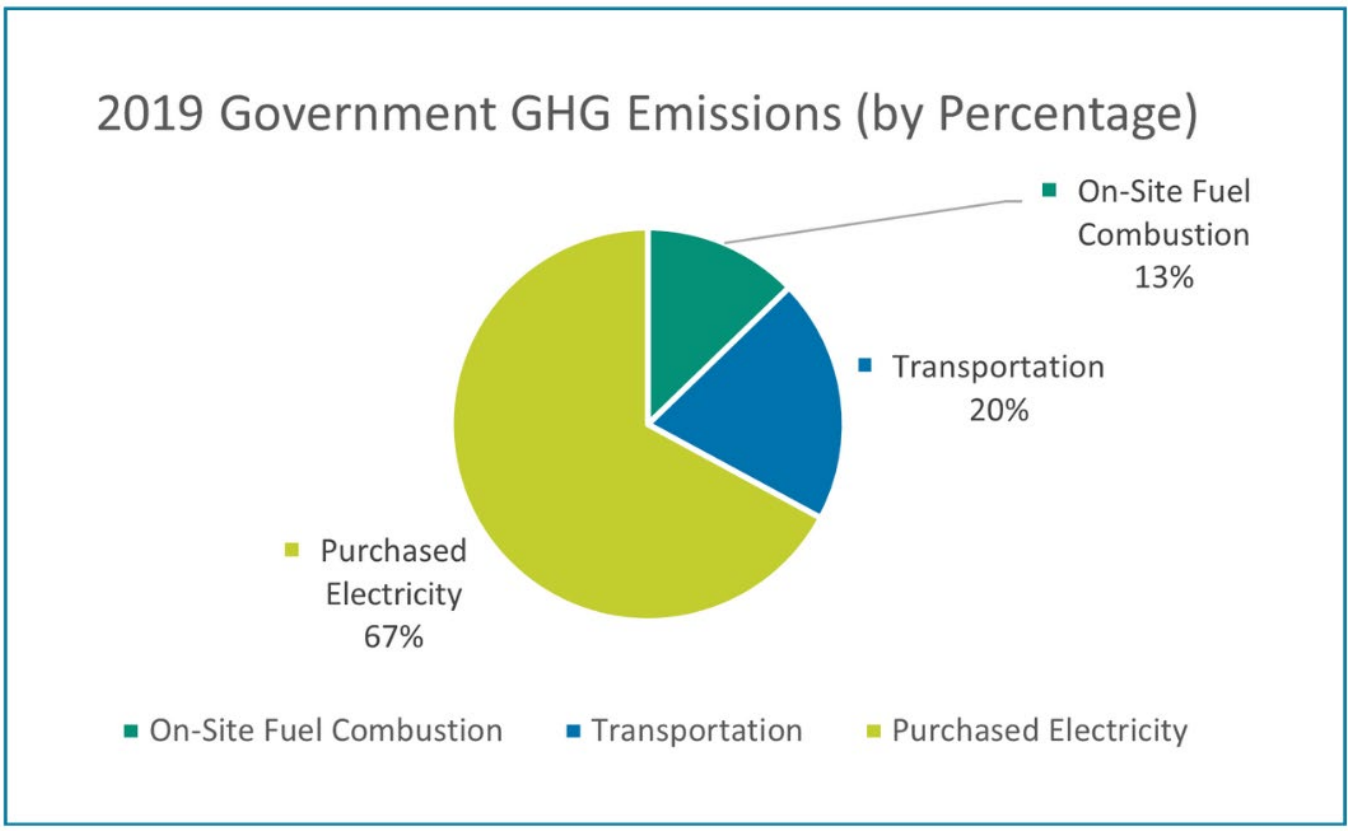
Wastewater and Water

The County operates water delivery and wastewater treatment facilities. These facilities use energy to operate and generate fugitive emissions from the decomposition of organic waste in wastewater. Energy-related emissions from water and wastewater treatment facilities are included in the Built Environment category; fugitive emissions are presented under this sector.

Emissions from Howard County Government Operations

Emissions from Howard County government operations have a different breakdown than the community-wide emissions. In 2019, Howard County government operations generated nearly 35,000 metric tons of carbon dioxide equivalent (MT CO_2e), representing only 1% of total community-wide emissions. The overwhelming majority of government operations emissions is from electricity use (67%), with County fleet fuel consumption contributing 20% of emissions and the remaining 13% coming from on-site fuel combustion.

Figure 16: Howard County's 2019 Government Operations GHG Emissions



Progress to Date

Howard County has made significant progress already by reducing greenhouse gas emissions 15% from 2005 levels. This is demonstrated through a comparison of the County's most recent 2019 GHG emissions inventory to previous emissions estimates from the baseline year of 2005.

The 2005 GHG emissions inventory is in part directly taken from Howard County's 2010 Climate Action Plan, which also was a community-wide plan. The rest of the 2005 data were estimated based on 2007 data presented in the 2010 Climate Action Plan. To make the 2005 data as consistent and as comparable to the 2019 information as possible, this report applied global warming potentials (GWPs) from the IPCC's Fourth Assessment Report (2007) to each type of greenhouse gas. In addition, this report estimated emissions for certain sources that were excluded from the previous inventory based on other publicly available data and proxy methods.

While efforts were made to allow comparability between the two inventory years, the inventories rely on different sources of data and methods and are not always directly comparable or consistent. The comparison shown here is a useful starting point to understand how the distribution of emissions have shifted over the past 15 years.

Since 2005, Howard County's community wide GHG emissions have dropped by 15%. Figure 17 shows the total GHG emissions in Howard County in 2005 and 2019. Figure 18 shows the breakdown of emissions by sector in 2005 and 2019. In the County's base year (2005) inventory, the built environment was the primary source of emissions; in 2019, transportation-related sources are the largest contributors to County emissions. This is consistent with trends across the United States; transportation surpassed building energy use as the primary driver of U.S. emissions in 2018.

Figure 17: Community Wide Total GHG Emissions in 2005 and 2019

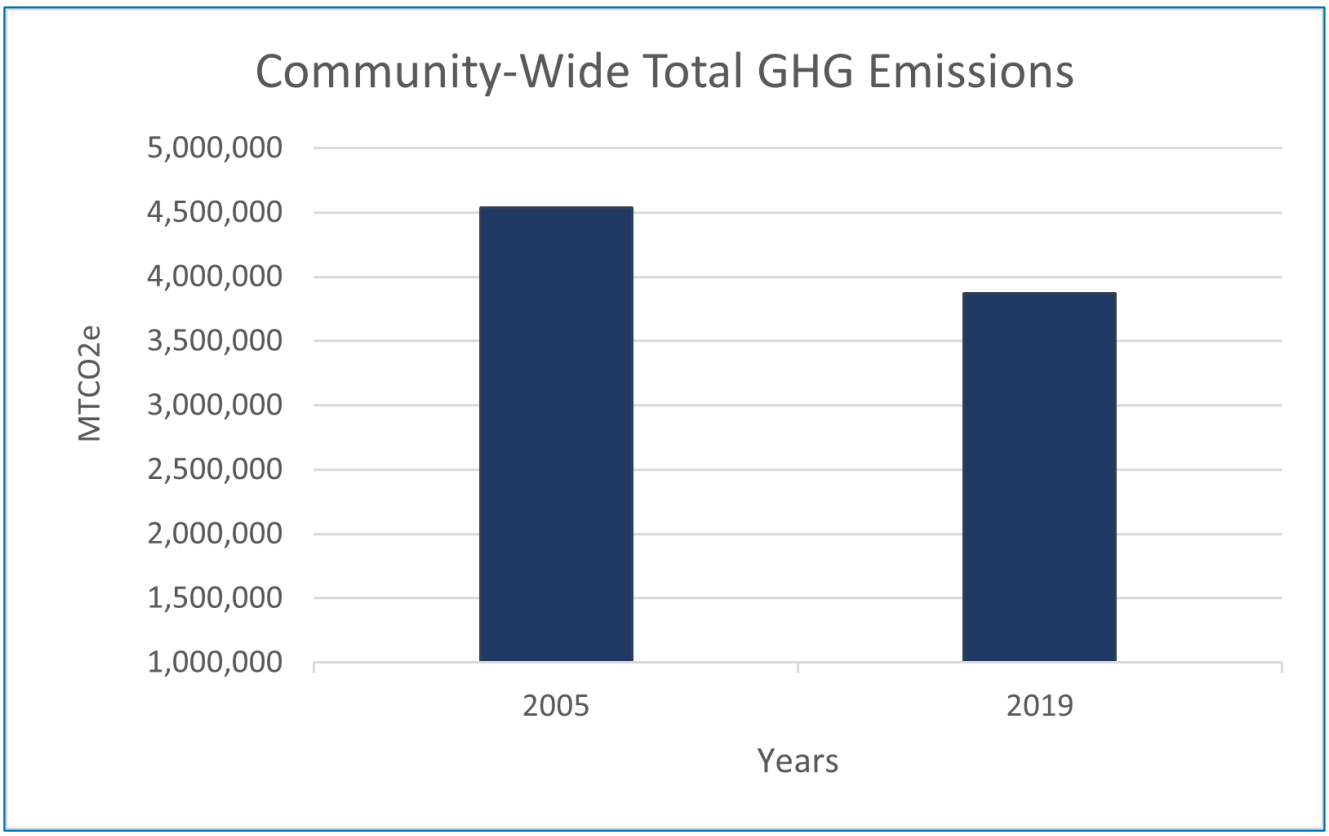


Figure 18: Estimated GHG Emissions by Sector in 2005 and 2019

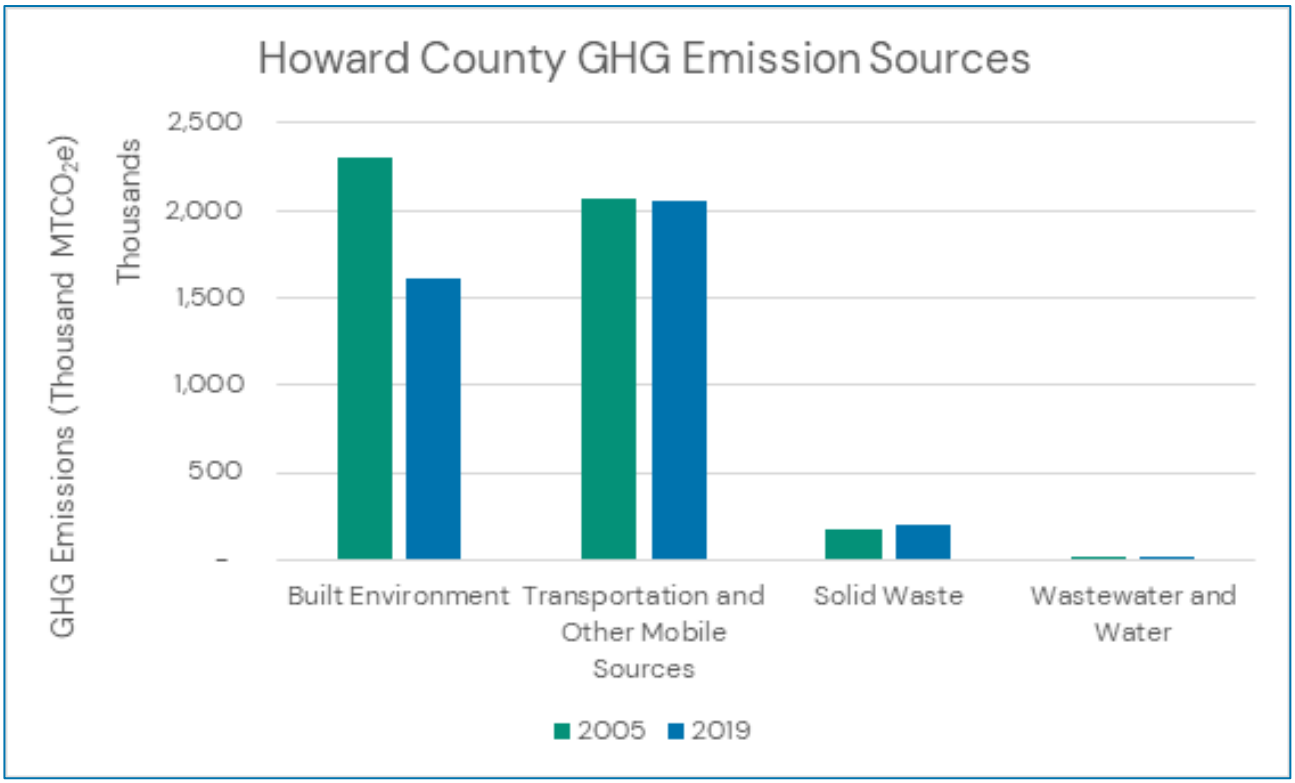


Table 3 below compares the County's emissions in 2005 and 2019 by source.

Table 3: Change in Howard County's GHG Emissions by Source from 2005 to 2019

GHG Emissions Source	2005 Emissions ($MTCO_2e$)	2019 Emissions ($MTCO_2e$)	Percent Change
Built Environment	2,300,887	1,607,068	-30%
Stationary Fuel Combustion*	555,774	410,564	-26%
Residential	376,022	224,764	
Commercial	179,752	185,800	
Industrial	-	-	
Electricity Use*	1,667,581	1,066,888	-36%
Residential	765,312	473,206	
Commercial	902,269	593,462	
Industrial	**	221	
Refrigerant Leakage	73,320	125,404	+71%
Industrial Emissions	4,212	4,212	0%
Transportation and Other Mobile Sources			
On-road transportation	2,063,842	2,057,172	-<1%
Solid Waste	167,855	205,013	+22%
In-County Disposal*	37,949	12,565	-67%
Out-of-County Disposal*	129,906	191,836	+48%
Composting	Not Estimated	613	N/A
Wastewater and Water			
Fugitive emissions	915	1,110	+21%
TOTAL	**4,533,499**	**3,870,364**	**-15%**

** Emissions are estimated based on 2007 values; 2005 data were unavailable.*

*** Included in commercial energy use.*

The reduction in emissions from the built environment was driven by reductions in both on-site stationary energy use and electricity use. For electricity use, total reported kWh used in the County increased by about 1% between 2005 and 2019, but emissions decreased by 36% due to a less carbon-intensive grid electricity mix in 2019.

While the inventory includes County-wide emissions from the community, emissions from government operations were also estimated. These are included in the totals above and presented in Table 4.

Howard County is proud to report that GHG emissions from government operations have been reduced by 30 percent between 2005 and 2019, which is double the reduction achieved community wide.

Table 4: Change in GHG Emissions from Howard County Government Operations from 2005 to 2019

Emissions Source	2005 Emissions ($MTCO_2e$)	2019 Emissions ($MTCO_2e$)	Percent Change
Stationary Fuel Combustion	2,751	4,446	+62%
Electricity Use	36,221	23,405	-35%
Government Fleet	10,800	7,034	-35%
TOTAL	**49,772**	**34,885**	**-30%**

It is interesting to note that while government fleet petroleum fuel use and electricity use emissions both decreased by 35% each, stationary fuel combustion increased 62% in the same time period. There are several potential explanations for this increase. One is that there may have been new County government buildings built during this time that use natural gas or heating oil rather than electricity for heat. It's also possible that additional diesel fuel was used for emergency generators during this time compared to 2005. Finally, it is possible that the data from 2005 did not include all of the stationary fuel sources due to lack of consolidated records, especially from purchases of heating oil and diesel fuel, which are not tracked by individual building in the same way that electricity and natural gas usage is tracked.

Future Business-As-Usual GHG Emissions Projections

Howard County anticipates that without additional action to reduce GHG emissions, the County's emissions from all public and private sector sources will increase by 3% and 5% in 2030 and 2045, respectively, compared to 2019. This projected increase is primarily driven by changes in population. The County's population is anticipated to grow by 13% between 2019 and 2045, which will result in increased energy use, vehicle miles traveled, and waste generation. During this time, there will also be a shift toward more renewable sources of grid electricity and increased use of electric vehicles, which offsets some of the increases in emissions due to population growth, so these changes have been factored into the projected emissions increases.

Emissions from transportation, the largest source of emissions in 2019, are expected to increase by 5% in 2030 and 4% in 2045 compared to 2019, and emissions from the built environment (the second largest source of emissions in 2019) will remain flat in 2030 and increase by 5% by 2045. Emissions from the other sectors are projected to increase roughly proportionally to population growth. See Figure 19 below.

Figure 19: Future GHG Emissions Projections in Business-as-Usual Scenario Including Changes in Electricity Generation Mix

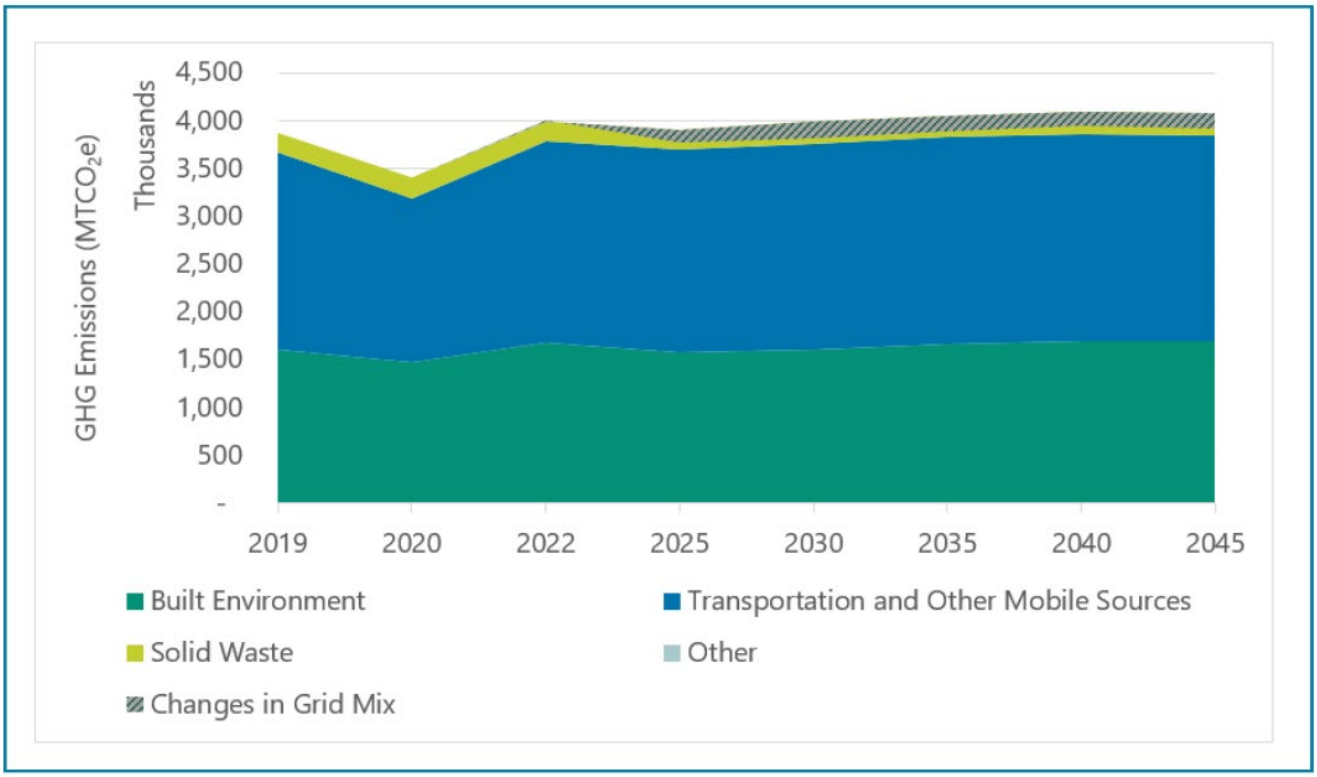
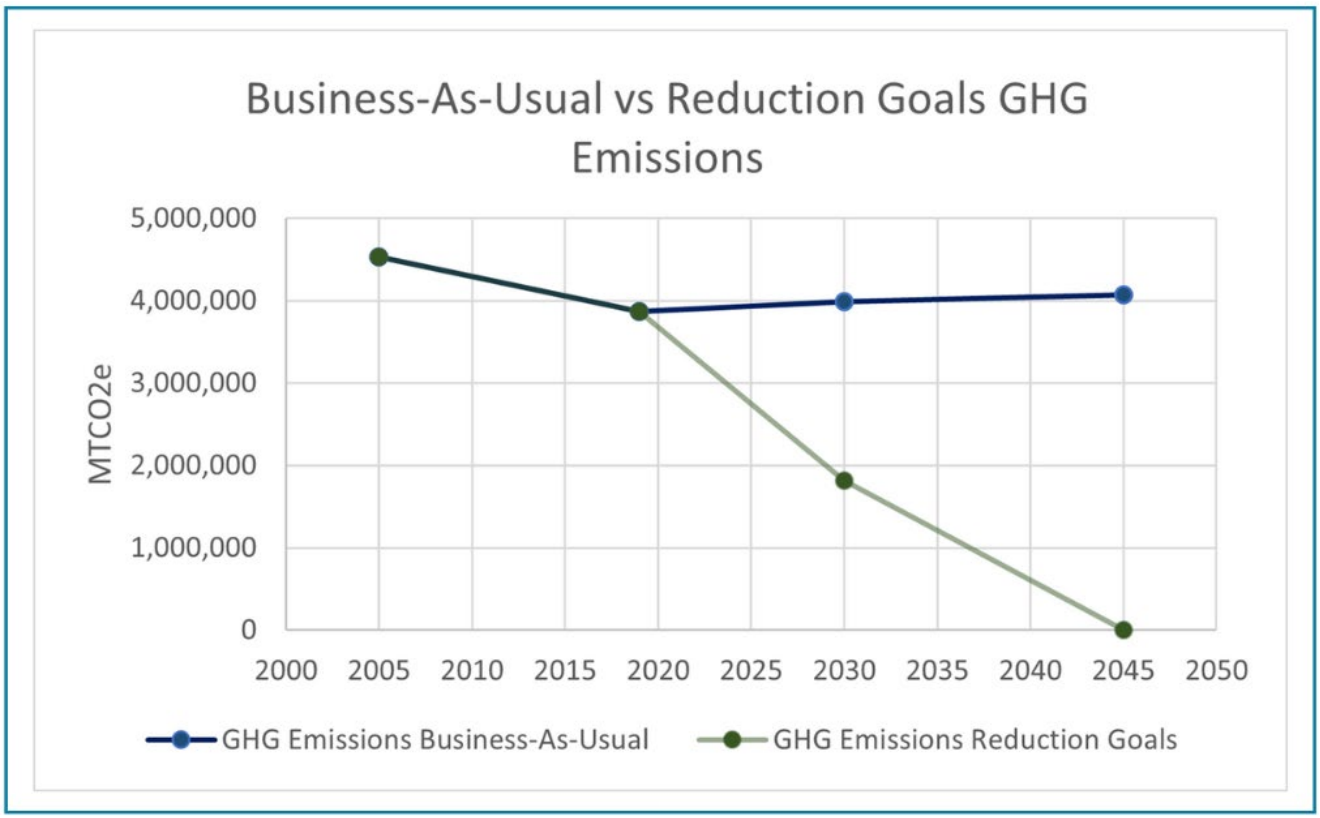


Table 5: Projected 2030 and 2045 Emissions under Business-As-Usual Scenario

Emissions Source	2019 Emissions ($MTCO_2e$)	Projected 2030 Emissions		Projected 2045 Emissions	
		($MTCO_2e$)	%	($MTCO_2e$)	%
Built Environment	1,607,068	1,609,411	+<1%	1,690,350	+5%
Stationary Fuel Combustion	410,564	449,857	+10%	465,438	+13%
Electricity Use	1,066,888	1,028,386	-4%	1,093,744	+3%
Refrigerant Leakage	125,404	125,404	-	125,404	-
Industrial Emissions	4,212	5,764	37%	5,764	37%
Transportation and Other Mobile Sources					
On-road transportation	2,057,172	2,150,309	+5%	2,148,926	+4%
Solid Waste	205,013	223,962	+10%	232,415	+13%
In-County Disposal	43,590	47,762	+10%	14,244	+13%
Out-of-County Disposal	160,810	176,200	+10%	217,476	+13%
Composting	613	671	+10%	695	+13%
Wastewater and Water					
Fugitive emissions	1,110	1,216	+10%	1,243	+13%
TOTAL	**3,872,091**	**3,987,297**	**+3%**	**4,072,934**	**+5%**

Figure 20: Comparison of expected GHG Emissions under Business as Usual and Howard County's GHG Emissions Reduction Goals



As Figure 20 shows, there is a big difference between emissions expected under business-as-usual conditions and Howard County's goals. To achieve Howard County's GHG emissions reduction goals of 60% by 2030 and net zero by 2045, Climate Forward includes key strategies for reducing emissions and sequestering (storing) carbon. As transportation and building energy use are the largest sources of the County's emissions, many of the strategies focus on the most impactful ways to reduce these emissions. This plan also includes strategies to reduce emissions from waste and to store carbon through nature-based climate solutions.

Federal and State Context

With proper attention and investment, County government can do a lot to reduce greenhouse gas emissions, sequester carbon, and improve resiliency to climate change. Howard County has already made great strides on sustainability and resiliency both within County operations and through education, outreach, and policy. As this report demonstrates, there are more actions the County can and must take to reduce greenhouse gas emissions, sequester carbon, and steward improved resiliency to climate hazards. However, County government alone is unable to solve the climate crisis. Many of the actions needed to reduce the impacts of and prepare for climate change are outside of the County's jurisdiction, geographic boundaries, or ability to control. Meeting the ambitious and crucial goals set forth in this Climate Action Plan will require coordinated and sustained efforts by not just County government but also all members of the community, including federal and state government, neighboring jurisdictions, residents, businesses, organizations, and other partners.

Strong federal and state policies, programs, and financial commitments are critical to addressing climate change. Local governments have limited jurisdictions and are unable to affect the types of sweeping and far-reaching changes that are possible with state and federal engagement.

Fortunately, recent actions at the state and federal level will help support the ambitious changes that are needed. The federal government, under the Biden Administration, has rejoined the Paris Agreement on climate change and has set a national goal to reduce greenhouse gas emissions 50% over 2005 levels by 2030 and to achieve net zero emissions by 2050. In April 2022, the State of Maryland passed the Climate Solutions Now Act (CSNA), which sets an even more aggressive goal of achieving net zero greenhouse gas emissions by 2045. The CSNA also includes funding sources and policy support that will help achieve that target across the state. Meanwhile, Congress recently passed two major pieces of legislation—the Infrastructure Investment and Jobs Act (IIJA) in 2021 and the Inflation Reduction Act (IRA) in 2022—which will mobilize billions of dollars to support efforts to reduce greenhouse gas emissions and increase infrastructure resiliency. In addition, the recent passage of the American Innovation and Manufacturing Act (AIM) also has great potential to reduce greenhouse gas emissions. Some of the most impactful results expected from these state and federal policies are noted below.

Climate Solutions Now Act (Maryland)

In April 2022, Maryland adopted the Climate Solutions Now Act (CSNA). This act sets a statewide goal of reducing greenhouse gas emissions by 60% of 2006 levels by 2031 and achieving net-zero reductions by 2045. The CSNA does the following:

- Requires state agencies to develop code recommendations and energy performance standards to significantly reduce the energy consumption of buildings.
- Incorporates long-term electric distribution planning necessary to decarbonize the electricity supply.
- Directs climate-related funding and efforts to benefit overburdened and underserved communities.
- Pilots an electric school bus program.
- Establishes new funding for a variety of climate initiatives.[19, 20]

Inflation Reduction Act (Federal)

In August 2022, Congress passed the Inflation Reduction Act (IRA), marking the largest federal clean energy and climate investment to date. The IRA does the following:

- Directs $369 billion for addressing domestic energy security and climate change.
- Increases resiliency of electrical grids.
- Funds and promotes low-carbon technologies and materials for homes and other buildings.
- Provides tax credits and other support to increase electric vehicle adoption.
- Covers incremental costs of zero-emissions school buses, garbage trucks, and transit buses.
- Funds energy efficiency upgrades, climate resilience measures, and electrification of affordable housing.

Infrastructure Investment and Jobs Act (Federal)

In November 2021, Congress passed the Infrastructure Investment and Jobs Act (IIJA)—also known as the Bipartisan Infrastructure Law (BIL). The IIJA includes $550 billion in federal funding to make our nation's infrastructure and economy more sustainable and resilient. Notably, IIJA focuses on investments designed to create a more climate-friendly and resilient energy and transportation sector through the following goals, and the creation of a new Grid Development Authority for electrification of the power grid:

- Directs $550 billion to make the nation's infrastructure and economy more sustainable and resilient.
- Supports public transportation improvements.
- Expands EV charging infrastructure.
- Improvements to roads and bridges with a focus on climate resilience.

The Federal Highway Administration (FHWA) estimates that Maryland could receive the following resources because of the IIJA:

- $4.7 billion to repair and rebuild roads and bridges with a focus on climate change mitigation, resilience, equity, and safety for all users, including cyclists and pedestrians.

- $1.8 billion over five years to improve public transportation options across the state.
- $63 million over five years to support expansion of an EV charging network in the state.

Finally, Howard County is eligible to compete for billions of dollars of competitive grants that cover topics like transportation system resilience, low- and zero-emission buses, and rehabilitating or replacing bridges and culverts.[21]

These and other state and federal initiatives go a long way toward curbing greenhouse gas emissions and improving climate resiliency in Howard County, Maryland, and the United States. However, more efforts will be needed at the state and federal level to reduce greenhouse gas emissions enough to avoid catastrophic climate change. Howard County will work with other local jurisdictions, activists, businesses, organizations, and other partners to advocate for additional positive change at the federal and state levels. For example, the County could support a 100% Renewable Portfolio Standard for Maryland because a carbon-free electricity grid is a foundational policy which unlocks the potential for lower emissions as transportation and building energy use continues to transition to electric power. The County also can push for additional financial investment at the state and federal level that can help accelerate a transition to carbon neutrality even more quickly.

Howard County Climate Solutions

Howard County, and the region at large, is positioned to experience increasing population growth and economic development at the same time its climate becomes more volatile due to climate change. Howard County must undertake strategies and actions to both mitigate GHG emissions across all sectors and increase the resilience of its underserved and under-resourced communities and its critical infrastructure.

To do so, Howard County has identified key strategies within three action areas:

- Governance strategies that address overarching governance within Howard County and are essential for successful implementation of the other strategies.
- Mitigation strategies whose primary focus is on reducing greenhouse gas emissions, although some may have co-benefits of increasing resilience as well.
- Resilience strategies whose primary focus is on enabling the County's infrastructure, population, and services to better withstand the challenges brought by climate change.

Within each strategy, the County also identified specific actions that should be implemented to achieve that strategy.

Howard County has chosen to focus on the strategies and actions that County government can take that have the greatest impacts in the near- and mid-term. These strategies and actions include updates to policies, plans, incentives, and regulations; education and outreach, working with partners; and making changes as needed to County facilities, fleet, and operations. The County identified priority governance, mitigation, and resiliency strategies based on:

1. Effectiveness in reducing GHG emissions or sequestering carbon.
2. Effectiveness in reducing identified climate risks.
3. Institutional and technical feasibility.
4. Alignment with climate goals and objectives.
5. Ability to reduce climate risks and impacts within underserved and under-resourced communities.

Howard County plans to periodically re-evaluate progress and adjust course if necessary and to tackle other important strategies once these top priority strategies are underway.

Climate and Equity Focused Governance

Everyday decisions and activities across nearly all elements of County operations impact greenhouse gas emissions and resiliency to the changing climate. From the equipment the County purchases to the types of vegetation it plants, to how it communicates internally and to the public, to how it manages information and data—all these actions can influence whether systems are set up to make smart climate decisions and create resiliency in the face of extreme weather events.

Therefore, it is crucial that climate action is not seen as something that is the responsibility of only one department. To truly tackle the challenges of climate change, climate-informed decisions must be made at every level, across all departments, on a routine basis.

Moreover, Howard County is committed to taking climate action in a way that is *equitable*. The impacts of climate change are not experienced uniformly across the County. Underserved and under-resourced communities can be more vulnerable to extreme weather events for a variety of reasons. For example, they may lack the resources to absorb higher utility bills or to pay for supplies, equipment, or upgrades that may make extreme weather events more tolerable. They may have fewer travel options to areas that provide resources during extreme weather events or have less access to critical resources. Populations that are more limited in mobility may be more greatly impacted if they cannot temporarily access safe facilities or other resources during climate hazard events. Populations with greater health concerns may be more vulnerable to the health impacts that accompany higher heat.

Similarly, the co-benefits of reducing greenhouse gas emissions are not necessarily uniformly distributed across populations. Improved weatherization of any building could reduce emissions, but weatherization may provide more co-benefits when it reduces utility bills for residents with lower incomes. Planting trees is a good thing to do throughout the County, but it may improve the quality of life more in areas that lack shade and trees.

Ensuring equity in climate action is a complex and nuanced endeavor—but it is achievable. Howard County believes that a single strategy or department focused on equity is not sufficient. Rather, equity must be woven into the overall approach to climate action to ensure that equity is accounted for in decision-making processes.

To achieve a successful and equitable implementation of this Climate Action Plan, Howard County will pursue the Climate and Equity Focused Governance Strategies listed below.

G-1: Establish a Climate Action Subcabinet

Working collaboratively with multiple agencies and departments during development of the Climate Action Plan fostered innovation and highlighted just how critical it is that all agencies and departments work together to tackle climate change. Through an Executive Order dated October 12, 2022, County Executive Calvin Ball established a Climate Action Subcabinet to ensure that implementation of this Climate Action Plan is a County-wide priority. The Climate Action Subcabinet will be a centralized committee of department heads and appointees who are responsible for coordinating across departments, establishing targets and milestones, and supporting County staff in implementing the strategies outlined in this plan.

The Subcabinet will also have topic-area committees to tackle strategies and actions that are most impactful and need the most cross-agency collaboration. The Climate Subcabinet will also be tasked with creating action items and timelines and overseeing Climate Forward implementation.

G-2: Prioritize Climate Action in all Aspects of Planning and Operations

This strategy will ensure that all levels of County government address climate change and will prioritize emissions reductions and climate resiliency in planning and operations. Climate change mitigation, carbon sequestration, and resiliency must be integrated into future codes, ordinances, and design manuals. County departments and offices need to adopt internal policies to prioritize climate action in purchasing, project management, community outreach, maintenance efforts and other aspects of operations.

G-3: Integrate Equity and Inclusivity into all Climate Action and Prioritize Communities Most Vulnerable to the Impacts of Climate Change

Climate change impacts underserved communities disproportionately. Climate mitigation and resiliency actions need to include measures to address and reduce these inequalities and disparities. This strategy will ensure that equity and inclusivity are integrated into every aspect of implementing climate action, including new or existing processes, projects, and programs. This Climate Action Plan will consider how greenhouse gas emission mitigation and resiliency strategies are implemented so that equity is maximized, and the communities most vulnerable to the impacts of climate change are prioritized.

G-4: Communicate Climate Action Progress Regularly and Transparently and Create Outreach that Engages the Community in Accomplishing Goals

Carrying out the strategies and actions in this Climate Action Plan will be a collaborative process involving the County, businesses, organizations, residents, and more. Transparent communication from the County will help ensure the community understands why these actions and strategies are being carried out and enlist their help in accomplishing goals. This strategy will ensure the community is aware of the Climate Action Plan's implementation process, progress, and successes.

G-5: Leverage State and Federal Programs and Funding Sources Whenever Possible to Advance Climate Action

Adequate and reliable funding is critical to the success of several of the strategies and actions outlined in this Plan. Significant state and federal legislation have been passed recently that increases resources available to combat and prepare for climate change. Maryland passed the Climate Solutions Now Act and the federal government passed the Infrastructure Investment and Jobs Act and the Inflation Reduction Act. In addition to new funding sources, there are many existing state, federal and non-governmental programs that provide funding, rebates, technical assistance, or other resources for climate initiatives. Under this strategy, the county will pursue state, federal, and non-governmental funding sources to support climate initiatives.

Mitigation Strategies: Reducing Emissions and Storing Carbon

Climate change mitigation means reducing or preventing greenhouse gas emissions. Substantial reductions in GHG emissions are required to prevent a rise in average global temperatures that could cause catastrophic impacts. It is impossible to eliminate all GHG emissions, however, as even natural processes contribute to these emissions. Therefore sequestration, or carbon storage, is equally important. Pulling carbon dioxide from the atmosphere and storing it in solid or liquid form is critical to reach Howard County's goal of net zero GHG emissions by 2045.

Howard County identified the most impactful, priority greenhouse gas mitigation and sequestration strategies. These strategies were selected as the most impactful, highest priority options because they reflect activities that the County has control or strong influence over, are feasible to implement from a technology or policy standpoint, and are expected to result in meaningful GHG emissions reductions and carbon sequestration.

The County was able to estimate the GHG emissions reduction potential for strategies in the Energy, Transportation, and Waste sectors, as shown in Table 6. The greatest reduction potential comes from the Energy and Transportation sectors, which makes sense as these are the largest sources of emissions found in Howard County.

The vast majority of the GHG emissions reductions needed to meet the County's 2045 net zero goal can be achieved through decarbonizing the grid, reducing energy use in buildings, increasing the adoption of electric vehicles, and reducing miles driven. This reduction potential reflects both the fact that such a large proportion of emissions are from building energy and transportation, and the large greenhouse gas benefits of moving toward cleaner energy sources.

While the Waste sector accounts for a smaller portion of the County's emissions and therefore mitigation potential, strategies targeting this sector were also included because they have a relatively low implementation cost, have direct involvement of the County, and will reduce the County's in-County waste emissions by at least one third. Finally, while waste is responsible for relatively low emissions in Howard County, it has a significant global impact on greenhouse gas emissions. Project Drawdown (2020), a comprehensive ranking of global climate solutions based on their potential for GHG reductions, ranks the reduction of food waste third out of all climate solutions.[22]

Reductions from nature-based strategies were not quantified formally, but these strategies will still make an important contribution to lowering the County's net greenhouse gas emissions, especially through carbon storage. Carbon storage benefits of nature-based strategies are expected to become easier to quantify in the future as new research and modeling tools are developed. In addition, these nature-based solutions also provide many co-benefits, including water quality improvement, flood reduction, pollinator habitat, and more. Page 40

Table 6: Summary of Howard County Mitigation Strategies

Mitigation Strategy	Mitigation Potential	GHG Reductions by 2030 ($MTCO_2e$)	% Reduction from 2005 totals by 2030	GHG Reductions by 2045 ($MTCO_2e$)	% Reduction from Business as Usual by 2045
E1: Reduce Greenhouse Gas Emissions from Existing Buildings	Moderate	181,687	4%	434,410	11%
E2: Construct Efficient and Low-Carbon Buildings	Low	7,805	<1%	35,537	1%
E3: Decarbonize the Energy Supply (includes emissions reductions from Maryland's current Renewable Portfolio Standard of 50% by 2030)	High	707,701	16%	968,597	24%
T1: Maximize the Use of Electric Vehicles	High	207,367	5%	1,137,249	28%
T2: Reduce Vehicle Miles Traveled in Single Occupancy Vehicles	Moderate	187,251	4%	253,840	6%
W1: Reduce Organic Waste Sent to Landfills and Manage Landfill Methane	Low	1,000	<1%	4,200	<1%
W2: Expand the Use of Sustainable Materials and Reduce Waste Generation and Disposal		Not quantified	Not quantified	Not quantified	Not quantified
N1: Support Nature Based Climate Solutions to Improve Soil Health, Increase Carbon Sequestration, and Reduce Emissions	Moderate	Not quantified	Not quantified	Not quantified	Not quantified
N2: Conserve Existing Forests and Expand the Tree Canopy	Moderate	Not quantified	Not quantified	Not quantified	Not quantified

These strategies go a long way toward achieving County goals. By 2030, the quantified strategies in Table 6 are estimated to reduce GHG emissions an additional 29% on top of the 15% reduction already achieved between 2005 and 2019. With just these strategies, Howard County can expect to reduce emissions 44% over 2005 levels by 2030. In addition, these strategies can reduce emissions 70% over the Business as Usual (BAU) predictions by 2045.

To fully achieve Howard County's goal of 60% reduction from 2005 emissions and net zero emissions by 2045, Howard County will need to reduce emissions an additional 16% by 2030 and 30% by 2045. These remaining reductions can be achieved through a combination of broader community action, carbon-sequestering nature-based solutions, additional state and federal level legislation, and technological advancements.

One example of impactful state legislation that could close the gap to achieve County goals is to change Maryland's Renewable Portfolio Standard (RPS) to 100% renewable electricity. A carbon-free electricity grid is a foundational policy which unlocks the potential for lower emissions as transportation and building energy use transitions to electricity sources. The IRA provides significant incentives toward grid decarbonization. A Renewable Portfolio Standard of 100% for the State of Maryland could reduce emissions in the County by an additional 12% by 2045.

Another source of emissions reductions not included in the above estimates are the reductions in refrigerant emissions expected because of the federal American Innovation and Manufacturing (AIM) Act of 2020. The AIM Act phases out high global warming potential (GWP) refrigerants over time. By 2045, Howard County should see an additional 2% emissions reduction because of the AIM Act.

Further, achieving the County's net zero goals will require nature-based solutions that increase carbon sequestration. More detailed modeling is needed to accurately understand the current agricultural and land use emissions and sequestration levels as well as the additional sequestration potential of specific strategies. However, a preliminary analysis using ICLEI Land Emissions and Removals Navigator (LEARN) Tool, found that county forests and other trees can offset approximately 6% of emissions. Additional nature-based solutions, such as reforestation, farming practices that cultivate healthy soils, and replacing mowed turf grass with native plant gardens, can store even more carbon each year.

Collectively, including the state and federal policies and nature-based climate solutions listed above with the strategies and actions outlined in this Climate Action and Resiliency Plan, Howard County can achieve 50% emissions reductions by 2030 and 90% emissions reductions by 2045.

In addition, emerging technologies can play a role in contributing to a lower emissions future. While a variety of established technologies exist today that reduce emissions, additional technologies can attain expanded commercial and economic viability through research and development. New and expanded technologies include sustainable refrigerants, fuel cells, advanced waste to energy, carbon capture utilization and sequestration, among many others. It is difficult to predict the role of future technologies, but future updates to this Plan will allow the County to adjust strategies to capture the potential of new technologies.

Also, Howard County plans to pursue the priority strategies identified in this plan over the next three to five years. After that, the County will likely add new priority strategies and actions that will ensure achievement of its ambitious climate goals. In addition, as Howard County begins to implement these strategies and actions and to evaluate their effectiveness, the County may adjust and modify the implementation steps, metrics, and priority actions as needed to best meet GHG emissions reduction goals.

Not only will Howard County government need to continue to commit to impactful climate actions, but there are many actions that can be undertaken by the community that can help reach and even surpass these goals. Recent federal and state legislation, including the Inflation Reduction Act, Infrastructure Investment and Jobs Act, and Maryland's Climate Solutions Now Act, include funding, rebates, tax incentives and other assistance to support mitigation actions by individuals, families, and businesses. Actions that individuals can take to help reach Howard County's climate goals are outlined in the Engaging the Community in Climate Action section.

Resiliency Strategies: Preparing for a Changing Climate

In addition to reducing GHG emissions and storing carbon, Howard County needs to ensure its citizens, plants, and wildlife are safe and healthy as the region experiences more frequent severe storms, flooding, and heat waves. As detailed in this report, Howard County has already experienced more extreme weather from climate change. These changes are expected to continue and to worsen, even if the world achieved global net zero GHG emissions within the next five or ten years. This report also details the vulnerabilities of the county's people, wildlife, agricultural resources, infrastructure and more.

The Resiliency Strategies included in this report are designed to help prepare for, recover from, and adapt to anticipated local climate impacts. Similarly to the Mitigation Strategies, Howard County has focused on the most critical priorities based on identified vulnerabilities as well as strategies that are within the County's ability to influence significantly.

Howard County's Resiliency Strategies will:

- Enhance emergency preparedness.
- Harden buildings, roads, and other infrastructure against extreme storms, flooding, and heat.
- Reduce heat islands and increase shade.
- Strengthen stormwater management on residential, commercial, and non-profit properties, treating both water quality and water quantity.
- Protect wetlands, forests, and streams.
- Direct resources toward underserved communities.

The report details several strategies and actions for each of these areas, including specific implementation steps, timeframes, and responsible parties.

Engaging the Community in Climate Action

Howard County government cannot meet the ambitious climate action goals outlined in Howard County Climate Forward without help from residents, businesses, and organizations. All of us can – and must – play an important role in mitigating the impacts of climate change. The individual choices made each day can significantly affect contributions to unwanted pollution and emissions. It's also critical that each of us is prepared for climate related emergencies and is aware of and has access to government and partner resources to survive and thrive in the changing climate. Together, we can achieve the needed GHG emissions reductions, carbon storage, and resiliency measures for our communities to survive and thrive now and in the future.

In Howard County Climate Forward, Howard County Government has outlined strategies, actions, and next steps to achieve climate goals. However, many of the next steps rely on outreach and education – and ultimately on behavior change resulting from education and outreach. To reach the maximum number of people, it will be most effective for government staff, local non-profits and concerned individuals to work together so that messaging can be reinforced and amplified.

There is so much work to be done that it can seem overwhelming. Therefore, prioritization is vital. For the next few years, it would be advisable to simplify and focus on a few topics. As progress is made, the messaging can be evaluated and modified to address new topics as needed. The following are key messages and actions to promote.

Maximize the Use of Electric Vehicles

Transportation accounts for 53% of GHG emissions in Howard County. To achieve emissions reduction goals, it is vital to reduce tail pipe emissions. This plan shows that electric vehicles have one of the largest potential impacts for reducing emissions. Currently, only 1% of personal vehicles in the county are electric. Increasing the percentage of EVs in Howard County to 50% can reduce GHG emissions 28% by 2045.

Action: Help family, friends, neighbors, and other community members purchase electric vehicles. Peer-to-peer ambassadors can share information and their personal experiences with EVs.

Information to share includes:

- Federal and State incentives.
- Local dealerships that are selling EVs.
- How to install home charging – create a list of local electricians that Howard County residents can recommend.
- Where to find charging stations – promote mobile apps and online mapping programs that provide this information.

Reduce Your Vehicle Miles Traveled

Not everyone will be able to convert to driving electric right away. Until EV's become more widely used, reducing the number of miles travelled alone in personal vehicles is another critical step in reducing GHG emissions. It's also one of the most cost-effective ways to do so since it doesn't require purchasing a new vehicle and can save individuals money on gas. Behavior change is hard to accomplish and measure but reducing the amount driven is crucial to reducing GHGs.

Action: Reduce vehicle miles traveled by driving less and helping others do the same.

- Combine trips by running errands on the way to other activities or running a series of errands at the same time. Google maps can be a great way to plan the most efficient driving routes for combined trips.
- Reduce idling. Idling is not necessary for vehicles, even in cold weather. Choose to park and go into restaurants, banks, and pharmacies rather than using the drive through option.
- Carpool with friends and neighbors to local activities.
- Telework whenever possible and encourage your employers to adopt flexible telework policies.
- Bike, walk, take the bus or train, and let your circle know how you are doing it. Invite friends and colleagues to join you, or post about it on social media. Make sure your friends, family, and colleagues know how to access trails and public transit.
- Encourage students to ride the bus to school or to walk or bike to school whenever possible. This helps reduce vehicle miles traveled and idling in the school drop off or pickup lines.

Use Less Energy in Homes and Community Spaces

Reducing GHG emissions from existing buildings is one of the most impactful climate actions since 42% of emissions come from the built environment.

Action: Help family, friends, neighbors, community spaces, and businesses conserve energy, make energy efficiency improvements, and electrify.

- Get an energy audit and implement the recommendations. Utility companies offer quick home energy check-ups at no additional cost and more detailed Home Performance with Energy Star audits for $100 (a $300 savings from the typical cost).

- Weatherize your home to reduce air leaks. Weatherization includes adding insulation, sealing leaks around windows, doors, switch plates, recessed lights, etc. If you are income-limited, you could qualify for free weatherization services from Community Action Council to save energy at home.
- Buy Energy STAR appliances with the highest energy efficiency ratings.
- Find out who oversees energy efficiency at your workplace and refer them to local programs, such as grants and loans through Maryland Energy Administration, C-PACE Energy Financing, and building tune up programs and rebates through BGE and Potomac Edison.
- Convert to heat pumps and other electric equipment whenever replacing a gas or oil heating system or appliance.
- Conserve energy at home and work by turning off lights when not in the room, connecting appliances to power strips and turning them off at the strip to avoid standby power, and by using a programmable thermostat. See livegreenhoward.com/energy for more tips.

Increase Use of Renewables

Decarbonizing the electricity supply is critical to reducing greenhouse gas emissions from buildings and from transportation, especially when moving toward greater adoption of electric vehicles and replacing natural gas and oil heat sources with electric ones. A great way individuals and organizations can make a difference is to help your family, workplace, and organizations you belong to make the switch to renewable power. This can include participating in community solar (a way to increase new, local solar projects and get the financial and environmental benefits of solar power without needing to own your home or have a shade-free roof), installing solar on your property, and even just switching your electricity provider to one that uses 100% wind or solar energy.

Action: Reduce barriers and decision fatigue around going renewable and increase participation in community solar, on-site solar, and renewable energy supply plans.

- If you have the means and appropriate location, add solar panels to your home. Build this into a scheduled roof replacement if that is needed.
- Become a solar ambassador by sharing information about your experience and recommended solar contractors to neighbors, friends, family, workplaces, and local organizations.
- Join a local community solar project and share information about your experiences with anyone with a local utility bill.
- Help increase awareness of community solar through your networks. Community solar has great potential but requires a lot of education so that more residents sign up. Consider holding a community solar webinar or promotion through a local non-profit. These sponsored sign-ups sometimes have an added bonus of a fundraising component for the organization.
- Direct people with questions to livegreenhoward.com and other sources of information.

Sequester Carbon with Trees, Plants and Healthy Soils

It is impossible to eliminate all sources of emissions, as even natural processes like decomposition of leaves and fallen tree trunks can release carbon into the atmosphere. Therefore, it is critical to do more to sequester or store carbon by taking good care of our land and natural areas. Most carbon storage from natural and working lands is achieved by plant roots and soil microbes, so it is critical to replace shallow rooted turf grass with deep rooted native flowers, grasses, and shrubs whenever possible. It's also very important to plant trees and to manage forests so they can be healthy and store more carbon than they release. In addition to storing carbon, healthy soils and native trees and plants also can reduce flooding, reduce urban heat islands, and provide habitat for pollinators and other wildlife. Seventy-three percent (73%) of land in Howard County is owned privately. Therefore, it is critical to help homeowners and other private landowners replace turf with trees and perennial plants.

Unfortunately, the social norm is to have overly manicured grass lawns in many residential and commercial properties – and even in our parks. This causes emissions from lawn-mowing in addition to reducing the carbon storage capacity of soils. However, studies have found that it only takes 25% of people in a group to adopt a new social norm to create a tipping point where the entire group follows suit.[23] This makes it even more critical for climate activists to adopt these land practices publicly and prominently.

Action: Plant more trees and native plant gardens. Work within neighborhoods to reach the tipping point to change social norms from turf grass to beautiful native plant meadows and gardens. Use signage, conversations, and other means to share information about these practices.

- Plant native plant gardens and native trees on your property prominently and include educational signage available from Howard County's Bee City Program or National Wildlife Foundation's Backyard Wildlife Habitat Certification Program.
- Use and promote programs that provide information and resources to help people convert turf grass to native plants and trees. Some of these include Howard County's Bee City Program, Homegrown National Park, and Howard County Master Gardeners.
- Local groups and gardeners can continue to share their passion and knowledge on local Facebook groups such as Maryland Native Gardeners and Howard County Gardeners.
- Let local schools, parks, homeowner's associations, and faith-based institutions know that native plants are welcome, beneficial, and beautiful. Help connect these organizations with funding and technical assistance from Howard County CleanScapes, Chesapeake Bay Trust, Howard County's Bee City Program, and others.
- Promote and attend local native plant sales such as Native Plant Palooza at Robinson Nature Center or Howard County Greenfest at Howard Community College. Develop lists of recommended native plant retailers to share with family, friends, and colleagues.
- Organize a speaker series or informational workshop on native plants for your neighbors or local organizations.

Reduce Food Waste and Encourage Plant-Rich Diets

Global food systems have benefitted society tremendously through increased access to affordable, accessible food across the United States and in Howard County. However, there are significant opportunities for improvement of these systems to become less wasteful. About a third of food does not even make it to consumers, and after that, there is more waste by consumers themselves.[24] In higher-income areas, the reasons for consumer food waste may include unattractive produce rejection, improper planning of meals causing food to go bad, and imbalances between supply and demand at the grocery store.[25] This causes emissions because when food breaks down in a landfill, it generates methane, a potent greenhouse gas. Individuals should also make a conscious effort to eat more plants as part of a well-rounded diet, as raising livestock accounts for nearly 15% of direct global emissions each year. This high number is due to the clearing of land to house and feed livestock and the direct emissions livestock like beef produces. Eating a plant-rich diet can also provide an added benefit of improving your health.

All of this means that reducing food waste and encouraging plant-rich diets are two of the most impactful actions an individual can take to reduce global emissions. Project Drawdown, a comprehensive ranking of climate solutions based on their potential to reduce greenhouse gas emissions, rated these two actions third and fourth, respectively, out of the top 100 actions to reduce emissions worldwide.[26]

Action: Reduce food waste at home and in the grocery store and switch to a more plant-based diet.

- Plan your meals ahead of time so that you only buy what you need at the grocery store. Consider keeping the foods that expire the quickest in the front of the refrigerator so they don't get forgotten.
- Participate in Howard County's curbside composting program or compost on your own property.
- Incorporate more plant-based meals into your routine. Even skipping meat-based meals once a week can make a big difference.

- Consider participating in an “ugly produce” program where less than perfect produce is sold directly to consumers.
- Support local farms to reduce the food waste produced during the shipping process. This can include buying food at local farmers’ markets and the Roving Radish Marketplace or signing up for a weekly box of produce from a local farm through a community supported agriculture (CSA) program.

Buy Less Stuff

Our hyper-convenient, disposable lifestyle is a very big challenge for the climate, wildlife, water quality, and even for our own health. Even though waste is a relatively small source of GHG emissions within the confines of Howard County, manufacturing and transporting goods result in high emissions in other places. These are considered indirect emissions and weren’t included in the GHG emissions inventory in this document because they can be very difficult to measure. However, the types and quantities of things bought and thrown away can have a big impact on the climate on a national and global scale.

Action: Reduce the amount of goods purchased and encourage others to do so as well.

- Practice and promote the five Rs: Refuse, Reduce, Reuse, Repurpose, and Recycle. Refuse means to not buy or take anything that you don’t really need, even if it’s offered for free. You can politely decline promotional freebies, single-use plastics, and anything else that isn’t truly essential.
- Promote simpler living and clutter-free gifts. Try to borrow items rather than buy them. Consider gifting food and other consumable items, experiences such as concert tickets, restaurant gift cards or subscriptions to museums.
- Participate in and promote the use of local groups, events, and resources that help people practice reuse and repurpose. These may include local “Buy Nothing” groups on social media, the Community Ecology Institute’s Repair Café to fix lamps and small appliances, DIY centers such as the tool lending center at Elkridge Branch Library, Habitat for Humanity’s ReStore for furniture and home project materials, and other consignment shops and thrift stores.

Mitigation Strategies

Energy

Strategy E1: Reduce Greenhouse Gas Emissions from Existing Buildings

Buildings continue to be a major source of greenhouse gas emissions in Howard County and throughout the region. These emissions come from a variety of sources, including on-site combustion of fuels in boilers and hot water heaters, electricity use, and leaking refrigerants. This strategy includes the implementation of building energy efficiency measures focused on lighting, HVAC, building control systems, and building envelope. This strategy also includes occupant education and behavior change programs to reduce the amount of electricity used. Actions from the County will build on existing work by the state including existing utility rebate programs and the state's Climate Solutions Now Act of 2022, which requires large buildings to meet direct emissions reductions through a building performance standard. Through this policy, buildings over 35,000 square feet must first report direct onsite emissions (for instance from boilers burning fossil fuels such as diesel, heating oil, or natural gas) by 2025, then reduce those emissions starting in 2030, eventually meet net zero direct onsite emissions by 2040, or face penalties. This strategy also builds on new incentives and rebates for electrification of home appliances through the federal Inflation Reduction Act. This strategy will:

- Focus on maximizing the effectiveness of residential retrofit programs and promoting and incentivizing efficient electric appliances including heat pumps, heat pump water heaters and induction stoves to improve residential and commercial energy efficiency.
- Develop educational materials and programs to encourage building occupants to reduce energy use by changing everyday behaviors.
- Pursue beneficial electrification to reduce natural gas, heating oil, and other high-emissions fuel use in existing buildings that meet specific criteria.
- Pursue strategies to use low-global-warming-potential refrigeration equipment to reduce fluorinated gas emissions from buildings.

Why These Actions?

Many energy efficiency improvements are cost-effective, and several existing programs can be leveraged for this effort, including EmPOWER Maryland and Community Action Council's weatherization assistance. One of the lowest cost methods to achieve significant energy savings is through occupant behavior, such as turning off lights and shutting down computers after use. Building electrification may seem to increase electricity use in buildings at first, as it typically replaces natural gas, heating oil, or other on-site fuel combustion. However, as the power grid is supplied by a greater percentage of renewable energy sources each year under Maryland's Renewable Portfolio Standard (RPS), beneficial electrification of existing buildings is an important pathway to decarbonization. New rebates expected through the Inflation Reduction Act will make electrification of home appliances more affordable to households making up to 150 percent of the median income in Howard County.

Addressing Equity

Increasing access to residential retrofits and rebates for underserved communities will improve occupant comfort and lower energy costs for residents. Electrification measures will reduce indoor air pollution from inefficient furnaces, water heaters, stoves, and other on-site combustion, which disproportionately impact disadvantaged communities.

Howard County Leading by Example

Howard County set a goal to reduce its energy use per square foot in government buildings 25% below 2019 levels by 2024. Howard County Government has already reduced energy use of government operations by converting traffic lights and streetlights to LEDs and implementing energy efficiency upgrades in its buildings.

GHG Emissions Reductions		Cost Considerations	Co-Benefits
2030 182k $MTCO_2e$ 4% reduction from 2005 baseline	2045 434k $MTCO_2e$ 11% reduction from projected 2045 emissions	Upfront Capital Improvement Costs Reduced Energy Costs	Improved efficiency will reduce energy costs for residents and businesses. Reduced onsite natural gas and heating oil use will reduce air pollution.

Action 1: Increase energy efficiency and conservation in all existing residential, commercial and government buildings.

This action will improve energy efficiency and conservation in existing buildings by leveraging and expanding upon existing utility and weatherization programs in the County and State. It also includes educating and incentivizing individuals and businesses to adopt cost-effective energy efficiency and conservation measures at home and at work. Residential energy efficiency measures may include weatherization, lighting upgrades, building envelope improvements, upgrades to more efficient appliances and HVAC equipment, and occupant behavior changes. Commercial measures may include lighting retrofits, more efficient HVAC equipment, building envelope improvements, retro-commissioning, and building automation, as well as occupant education and behavior change. Individual behavior changes at work and at home may include turning out lights or shutting down computers when not in use. Also under this action, Howard County government will continue to implement energy efficiency and conservation measures in its own buildings.

Overcoming Barriers

While a large variety of great energy efficiency and conservation options are available, many people have not yet adopted these practices, even with the inducements of rebates, incentives, and cost savings. Education on existing programs, funding opportunities, and co-benefits of energy efficiency and conservation can help increase adoption of energy saving measures in homes and businesses. In addition, partnerships and grants can help expand existing programs beyond their current reach.

Tracking Progress

This action will seek to achieve electricity savings of 0.5% per year initially, ramping up to 3% annual savings for residential and 2.5% for commercial by 2045. These annual electricity savings achieve a total savings of 30% for residential and 25% for commercial buildings over 2022 levels by 2045. Annual gas savings from energy efficiency measures will begin at 1.1%, ramping up to 2% by 2045. These annual gas savings achieve a total savings of 20% for all building types over 2022 levels by 2045. The metric table below shows electricity savings measured in megawatt hours (MWh) where each megawatt is 1,000 kilowatts (kWh). Natural gas savings are measured in MMBtu or one million British thermal units. The British thermal unit or Btu is a standard unit of measurement of the energy content in fuel.

Metric	Baseline	Goal
Cumulative residential electricity use savings	0 MWh	177,000 MWh (2030) 839,000 MWh (2045)
Cumultive commercial electricity use savings	0 MWh	233,000 MWh (2030) 945,000 MWh (2045)

Cumulative residential natural gas use savings	0 MMBtu	446,000 MMBtu (2030) 1,633,501 MMBtu (2045)
Cumulative commercial natural gas use savings	0 MMBtu	376,000 MMBtu (2030) 1,328,000 MMBtu (2045)

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer for this action, with support from Department of Community Resources and Services (DCRS), Department of Public Works – Facilities (DPW – Facilities), Howard County Economic Development Authority (EDA) and Department of Finance (Finance).

Next Steps	Timeline	Responsibility
Work with local utilities and their partners to increase participation in existing commercial and residential energy efficiency incentive programs. Encourage homeowners, landlords, and contractors to take advantage of all new rebates that become available. Encourage businesses, organizations, and schools to apply for state energy efficiency grants and low-interest loans offered by Maryland Energy Administration.	2023-2024	OCS
Promote energy conservation at work and home through outreach and events. These may include LED light bulb exchanges, educational material development and distribution, contests such as Battle of the Buildings, and outreach through newsletters, blogs, social media, and websites.	2023-2024	OCS
Expand residential retrofit programs such as the Community Action Council's and Civic Works' weatherization efforts and Rebuilding Together's home repairs, with specific emphasis on underserved markets. Support these organizations in pursuing federal grant programs for this expansion including the upcoming energy efficiency block grant program. Educate residents about the availability of these programs and encourage them to reach out to these organizations to request energy and cost saving services, such as free energy audits and weatherization services.	2023-2024	OCS, DCRS
Expand the use of C-PACE for commercial properties. Work with the Chamber of Commerce and other partners to promote the program to local businesses. Commercial Property Assessed Clean Energy (C-PACE) is a clean energy loan program that allows property owners to pay back qualifying loans through their property tax bills. Howard County Council recently expanded C-PACE to include energy efficiency, renewables, resiliency improvements, and occupant health improvements. The Council legislation also encourages electrification by prohibiting the use of C-PACE loan funds for gas-powered boilers, furnaces, hot water heaters, or cooking appliances.	2023 and ongoing	OCS, Finance, EDA
Educate local businesses and nonprofits about opportunities for state grants and loans, as well as utility rebates through the EmPOWER Maryland program. These rebates include funding for building tune ups and for installation of energy efficient equipment.	2023-2024	OCS, EDA

Establish a benchmarking program to support compliance with the state's planned Building Energy Performance Standard. In addition to benchmarking the direct emissions from on-site combustion, include options for benchmarking electricity use using Energy Star Portfolio Manager to raise awareness of energy efficiency gaps. Begin by benchmarking County buildings and publishing results to lead by example.	2023-2025	OCS
Explore requiring energy audits as part of commercial property sales, especially for larger buildings.	2023-2025	OCS
Include energy efficiency review at the beginning of systemic (existing building) projects at County government facilities as appropriate to maximize energy savings and grant opportunities. Consider replacement of equipment with the most energy efficient option available. OCS and Facilities to meet at the beginning of each fiscal year to review planned projects and discuss energy saving opportunities.	2023 and ongoing	DPW – Facilities, OCS
Identify needs for additional funding, staffing, and staff training for preventive maintenance in County government buildings.	2023-2024	DPW – Facilities
Increase funding, staffing, and staff training for building maintenance in Howard County government buildings to ensure all preventive maintenance is performed on schedule and that all building automation systems are monitored and adjusted for maximum energy savings.	2024-2025	DPW – Facilities
Provide regular reporting on energy consumption per square foot in County government buildings to upper management. Prioritize County government facilities for energy saving projects and implement those projects wherever possible with County and grant funding.	2023 and ongoing	OCS, DPW – Facilities

Action 2: Increase electrification in existing residential, commercial and government buildings.

Building electrification means replacing boilers, hot water heaters, and other equipment that use on-site combustion of fossil fuels (natural gas, heating oil, etc.) to high-efficiency equipment that runs on electricity, such as cold weather heat pumps or heat pump water heaters. Paired with grid decarbonization, electrification can significantly reduce emissions from buildings. Electrification not only reduces greenhouse gas emissions, but also can result in improved performance, reduced costs, or other added benefits. For example, when used in certain buildings electric heating and hot water can reduce energy costs as well as emissions. Replacing gas stoves with electric can improve indoor air quality and human health.

Overcoming Barriers

Many consumers have concerns about whether heat pumps will work as well as boilers and other more familiar technologies. While lifetime costs of heat pumps are typically lower than that of natural gas or oil boilers, upfront costs of heat pumps can be greater, which can be a barrier. Improved education on the efficiency, efficacy, and potential savings from using heat pumps, even in below-freezing temperatures, as well as education on the benefits of electrification may help bolster adoption. Most people are not yet aware of the new rebates and incentives for electrification of major home appliances that will be available through Inflation Reduction Act funds starting in 2023. Formulas to determine eligibility and allowable rebate amounts are complicated and individuals and contractors may need educational resources to fully understand how to make the best use of these new incentives. Additionally, installing new electric equipment in existing homes and commercial buildings may require electric panel upgrades or new electrical service depending upon existing capacity and use. Upgrading a building or home to electric requires a plan.

First, determine whether electrical upgrades are needed prior to the installation of the electric equipment. This will avoid a situation where the existing boilers and water heaters reach their end-of-life before the building is ready for the switch. Once existing equipment breaks, there is typically a need to replace equipment as quickly as possible, so it is more likely that building occupants will choose to replace gas and oil equipment with the same rather than add extra steps, time, and money to prepare for electric upgrades. Finally, education efforts focused on HVAC technicians and contractors also is key, as their clients often follow their recommendations when choosing new equipment.

Tracking Progress

This action focuses on replacement of boilers, hot water heaters, and other equipment that use on-site combustion of fossil fuels with electric equipment as the existing equipment breaks down and requires replacement. This action also encourages preparation for electrification prior to equipment breakdown. While some residents and businesses would switch to electric systems without additional incentives or education, the outreach and pilot programs outlined in this action have the potential to dramatically increase the rate of electrification. Under this action, the number of buildings that rely on on-site combustion of fossil fuels (described as eligible buildings in the chart below) will steadily decrease over time.

Metric	Baseline	Goal
Percent of eligible residential buildings that have implemented electrification	0%	20% (2030) 80% (2045)
Percent of eligible commercial and government buildings that have implemented electrification	0%	10% (2030) 59% (2045)

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer for this action, with support from Howard County Economic Development Authority (EDA), and Office of Workforce Development (OWD).

Next Steps	Timeline	Responsibility
Support efforts to expand EmPOWER Maryland to include incentives for converting from oil and gas heat and appliances to electric. The Climate Solutions Now Act includes an initial step toward this work by changing utility programs for low-income customers and allowing utility programs to lower bills by switching to all electric heating rather than simply retrofitting to more efficient fossil fuel systems. Also seek inclusion of incentives for electric panel and/or electric service upgrades prior to electrification.	2023-2024	OCS
Educate the community, including residents and businesses, about state and federal incentives and programs promoting electric and efficient appliances, such as ENERGY STAR, EmPOWER Maryland, and new incentives available through the Inflation Reduction Act or other legislation. Provide educational materials as needed to help individuals and businesses understand their eligibility and how to maximize rebate and tax incentives for electrification.	2023-2025	OCS, EDA

Educate the community about the benefits of electrification, including lifetime cost savings, improved indoor air quality, and more. Include targeted education about the effectiveness of high efficiency heat pumps at cost-effectively and comfortably heating homes and smaller commercial buildings even in extreme cold temperatures. Also include education about the safety and time-saving benefits of electric induction ranges. Prioritize populations in buildings currently using oil heat for education programs.	2023-2025	OCS, EDA
Develop pilot programs as needed to test, demonstrate, fund, and implement electrification projects, especially in underserved communities and/or with small businesses. These pilot programs may include electric heat pumps and water heaters as well as electric stoves, electric dryers, and more. Prioritize buildings currently using oil heat whenever possible.	2023-2025	OCS, EDA
Reach out to HVAC and electrician professionals to discuss barriers they face in recommending and installing electric equipment. Partner with trade and professional associations, apprentice programs, community colleges, and others to develop and implement training as needed for current and future HVAC and electrician professionals.	2023-2025	OCS, OWD
Consider options for additional incentives and/or workforce development programs to help homeowners and commercial building owners to prepare for electrification with energy audits, electric infrastructure audits, and any needed upgrades to electrical panels and service. Prioritize income-restricted households and small businesses for any new incentives.	2025-2026	OCS, OWD
Explore requiring electric equipment audits and any needed panel and service upgrades as part of property sales.	2025-2026	OCS

Action 3: Accelerate the adoption of low GWP refrigeration and air conditioning equipment in commercial properties and reduce refrigerant leaks.

Refrigerant leaks can be a significant source of emissions as these chemicals typically are much more potent greenhouse gases than carbon dioxide and therefore have a high global warming potential (GWP) and contribute exponentially to climate change. Refrigerant leaks also can be costly because leaky systems need to be recharged more frequently. The American Innovation and Manufacturing Act (AIM) passed in 2020 phases down the consumption of hydrofluorocarbons (HFCs) currently used as refrigerants, by 85 percent over the next 15 years in favor of lower-GWP alternatives. AIM will result in significant GHG emissions reductions nationwide but will be slow to reach its fullest potential impacts because existing equipment using HFCs may still be in use for decades to come. In addition to waiting for commercial property owners to replace aging equipment with equipment containing lower-GWP refrigerants, this action supports proactive measures to reduce refrigerant leaks and begin replacing outdated equipment with low-GWP alternatives even before HFCs are mostly phased out. Howard County can lead by example through regular refrigerant system maintenance and replacing outdated equipment with low-GWP alternatives in County buildings. In addition, Howard County can help food retail and other businesses access available programs to help them follow best practices in refrigeration.

Overcoming Barriers

Commercial property owners may not be aware of the options for lower-GWP refrigerants. In addition, appliances with lower-GWP refrigerants may not be readily available, though the AIM Act will ensure greater availability in the future. Commercial property owners also may not be aware of opportunities for cost savings, technical support, and community recognition that can come from participation in partner programs such as the U.S. Environmental Protection Agency's GreenChill program.

Tracking Progress

This action seeks to reduce GHG emissions from HFCs used by commercial properties through supporting enrollment in existing programs, such as GreenChill, a voluntary U.S. Environmental Protection Agency partnership program that works

with the food retail industry to reduce refrigerant emissions. The GreenChill program can help educate businesses about their options for refrigerant systems and help them develop proactive plans for maintaining, retrofitting and/or upgrading systems.

Metric	Baseline	Goal
Store enrollment in EPA's GreenChill program	1 store	34% of stores enrolled (2030) 83% of stores enrolled (2045)

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer for this action, with support from Department of Public Works -Facilities (DPW – Facilities) and Department of Public Works -Environmental Services (DPW-ES), and Howard County Economic Development Authority (EDA).

Next Steps	Timeline	Responsibility
Identify existing programs focused on encouraging adoption of lower-GWP refrigerants (e.g., federal GreenChill program) and reach out to these programs regarding County-level partnership opportunities.	2023-2024	OCS, EDA
Educate the community about federal programs promoting lower-GWP appliances, refrigerant leak mitigation, and responsible appliance disposal (e.g., EPA's Responsible Appliance Disposal Program).	2023-2024	OCS, DPW – ES
Ensure responsible recycling of HFC-containing equipment though community education.	2023-2025	OCS, DPW – ES
Continue to perform regular maintenance of refrigerant systems in County buildings. Increase funding and staffing for maintenance as novel lower-GWP systems are implemented.	Ongoing	DPW – Facilities

Strategy E2: Construct Efficient and Low-Carbon Buildings

New buildings should be highly efficient and emit the least carbon possible. By integrating green design principles, energy efficiency, and electrification in new buildings, the public and private sectors can avoid having to later retrofit these buildings to comply with Maryland's Climate Solutions Now Action of 2022 and other regulations.

By implementing this strategy, Howard County will:

- Develop and implement more stringent green building standards to maximize energy efficiency and decarbonize new construction.
- Limit the use of high-global-warming potential refrigeration and air conditioning equipment in new construction.

Why These Actions?

Incorporating energy efficiency into new construction is one of the most cost-effective ways to limit future emissions. Adopting the International Green Construction Code overlay and/or another energy efficiency or green building standard would further increase energy efficiency in new construction. In addition, electrification of most new construction will be necessary to meet requirements under Maryland's Climate Solutions Now Act, which gradually phases out onsite fuel combustion in buildings.

Addressing Equity

This strategy will incentivize highly efficient new construction, improving occupant comfort and lowering energy costs for residents. Electrification measures will reduce indoor air pollution from inefficient furnaces, water heaters, stoves, and other on-site combustion, which disproportionately impact underserved communities.

Howard County Leading by Example

New County government buildings greater than 10,000 square feet are required to achieve LEED Silver Certification to maximize efficiency and reduce the environmental impact of new construction, and in many cases, Howard County has achieved LEED Gold or LEED Platinum for new buildings. For example, the Howard County Circuit Courthouse, completed in 2021, achieved LEED Gold with many points achieved for energy efficiency and renewable energy.

Howard County's Department of Inspections, Licenses and Permits staff are active participants in several International Code Council committees and workgroups that continuously revise and update codes to best protect people and property, as well as save energy and reduce life cycle building costs. As of 2022, Howard County has adopted all the most recent versions of international building codes, except for the International Green Construction Code overlay. The adoption of modern building codes is rare among local jurisdictions in the United States, with only about one-third of communities adopting the most modern codes. This prompted a new federal effort to increase adoption of modern building codes, called the National Initiative to Advance Building Codes.

<table>
<tr><th colspan="2">GHG Emissions Reductions</th><th>Cost Considerations</th><th>Co-Benefits</th></tr>
<tr><td>2030
7.8k $MTCO_2e$
<1% reduction from 2005 baseline</td><td>2045
35.5k $MTCO_2e$
1% reduction from projected 2045 emissions</td><td>Potential upfront costs for green building.
Reduced energy and maintenance costs.</td><td>Improved efficiency will reduce energy costs for residents and businesses.
Reduced onsite natural gas use will reduce air pollution and benefit public health.</td></tr>
</table>

Action 1: Implement more stringent green building standards for new residential, commercial, and government properties.

This action increases the energy efficiency of new construction and major renovations. To encourage compliance with green building codes, Howard County will work with the construction community to educate and train contractors and their workforce on green building benefits, new approaches and technology, and installation techniques. Howard County also will continue to actively engage with the state on the timing and process for adoption and implementation of new energy codes.

Overcoming Barriers

Barriers to new green and energy efficient buildings can come from a range of items including, education of project developers, access to construction materials and skilled laborers, and the higher cost of construction. In addition, code compliance is crucial for the benefits of a more energy-efficiency focused code to be realized. Further, a review of existing code requirements will be important to identify potential barriers to development of green buildings (e.g., fire code requirements and batteries). Howard County also needs to consider costs for home buyers and renters, particularly those with low and moderate incomes, when adopting and implementing code requirements. Finally, to adopt the International Green Construction Code overlay and/or other green building standards, Howard County Department of Inspections, Licenses and Permits will need additional funding and staff to conduct required inspections following building occupancy to ensure energy efficiency goals are met in each new building.

Tracking Progress

This action assumes that green building standards such as the International Green Construction Code (IgCC), Net Zero Energy code, or Green Globe, push new construction to reach energy efficiency levels above required International Construction Code (ICC) standards. New building codes are developed every three years and Howard County is one of the

earliest adopters of new codes across the country. Howard County has not yet adopted the IGCC or other green building standards, so there is good potential to reduce energy consumption and reduce GHG emissions through adoption of a green building standard. This Climate Action and Resilience Plan assumes a 95% compliance rate with a new green building or energy efficiency code.

Metric	Baseline	Goal
New Code Adoption	Existing Code Requirements	A new green building standard adopted for Howard County. (2027)

Implementation

The Department of Inspections, Licenses, and Permits (DILP) will be the lead implementer for this action, with support from the Office of Community Sustainability (OCS), Department of Planning and Zoning (DPZ), and Department of Public Works – Facilities (DPW – Facilities). Adoption of new codes is a responsibility of County Council.

Next Steps	Timeline	Responsibility
Research green building standards that support the construction of highly energy efficient new buildings and/or net zero emission buildings. Options may include IgCC, LEED, Green Globes, a variety of Net Zero energy standards, etc. Determine any resources needed to support new codes and ensure these resources are available before codes are adopted.	2023-2024	DILP, OCS
Adopt new green building standards and/or energy efficiency codes as appropriate through the standard three-year code adoption cycle.	2024-2027	DILP, County Council
Educate the construction community on the benefits of energy efficiency focused code, and brief them on the specific code updates, particularly on the residential side. This includes educating general contractors, but also trades people on quality and acceptable installation practices for things like insulation, weather resistant barriers, and other newer energy efficiency approaches.	2024-2027	DILP (and statewide partners)
Continue to conduct energy efficiency review for Howard County government building projects greater than 10,000 square feet with the goal to maximize energy efficiency and minimize carbon emissions in each new construction project. Encourage HCPSS to do the same.	Ongoing	DPW – Facilities, OCS, HCPSS
Explore options to modify local incentives (including monetary, zoning, building credits, etc.) and/or regulations to promote green buildings that provide additional energy efficiency beyond what is required by code. Also consider options to incentivize smaller residential units (houses, townhouses, apartments) and/or to disincentivize larger residential units.	2023-2025	DILP, OCS, Finance, DPZ
Adopt modifications to local incentives and/or regulations as needed to improve energy efficiency of new buildings beyond code requirements and/or to incentivize smaller building size.	2024-2026	DILP, OCS, Finance, DPZ

Action 2: Phase-in requirements for all-electric new construction for residential, commercial and government properties.

When paired with decarbonization of grid electricity, all-electric buildings reduce on-site fuel combustion and associated GHG emissions. This action considers phasing in requirements for all new residential and commercial construction to be all-electric, with an initial emphasis on buildings which are the most cost-effective to electrify. Howard County Council

also is considering including electrification in future construction code updates. In early 2023 the Council passed legislation (2023-CB5) requiring the County Executive to produce a report including recommendations on how to incorporate electrification into code for new construction. This action broadly aligns with Maryland's Climate Solutions Now Act which requires net–zero on-site fuel combustion by 2040 for many buildings.

Overcoming Barriers

Public education about the cost effectiveness of electrification will be crucial as higher upfront costs can mask lifetime savings.

Tracking Progress

While Howard County's exact path toward and timing of electrification is subject to future code changes, the modeling to determine GHG emission reduction potential for this action assumes 100% of new residential construction and 38% of new commercial buildings will be electric beginning in 2025. By 2035, the assumption changes to 100% electric new construction across residential, commercial, and government buildings.

Metric	Baseline	Goal
Percentage of new residential buildings that are all-electric	Unknown	100% (2030) 100% (2045)
Percentage of new commercial buildings that are all-electric	Unknown	38% (2030) 100% (2045)

Implementation

The Department of Inspections, Licenses and Permits (DILP) will be the lead implementer for this action, with support from the Office of Community Sustainability (OCS) and Howard County Economic Development Authority (EDA).

Next Steps	Timeline	Responsibility
Develop educational materials to address public concerns regarding electrification (utility infrastructure, grid carbon intensity, battery storage, etc.) and benefits of electrification (improved indoor air quality, life cycle cost savings, etc.).	2023	OCS
Research and report on options for including electrification requirements in construction code.	2023-2024	DILP, OCS
Implement electrification requirements as adopted in the code, which requires action by Howard County Council. International construction code updates typically take place every three years, with updates anticipated in 2024 and 2027.	TBD	DILP
Identify potential community partners to help support electrification efforts (e.g., coordination with Columbia Association, HCPSS, and Howard Community College to support electrification within their building portfolios).	2023-2025	OCS
Educate the construction and real estate community regarding the benefits of electrification and any grants, rebates, or other incentives to implement electrification of new construction.	2023-2025	DILP, OCS, EDA
Educate the construction and real estate community regarding the potential use of geothermal. Provide information on incentives and technical assistance opportunities for geothermal installation.	2023-2025	OCS, EDA

Incorporate requirements into building standards that promote the use of low-GWP refrigerant equipment in new buildings.	2024-2025	DILP

Strategy E3: Decarbonize the Energy Supply

A clean energy grid with a carbon-free fuel mix is a foundational strategy because it enables both vehicle and building electrification to dramatically reduce emissions. Maryland's Renewable Portfolio Standard requires half of the state's electricity to come from renewable sources by 2030, with 14.5% carved out for solar. This state requirement is expected to reduce GHG emissions in Howard County 15% by 2045. Howard County can increase the emission reduction potential to 24% by supporting local renewable energy development and use through education, outreach, eliminating barriers, or considering new options for incentives.

Through implementing this strategy, Howard County will:

- Create outreach programs to increase the use of on-site solar, community solar, and third-party suppliers that offer 100 percent renewable energy options.
- Increase incentives for onsite solar development through codes, zoning, tax relief, or other options.
- Expand the development of onsite solar energy for residential, commercial and government properties.

Why These Actions?

These actions will help expand the local use of renewable energy and decarbonize electricity supply. Currently, 28% of the County's greenhouse gas emissions come from electricity generation. Electrification of buildings and transportation will significantly increase electricity consumption in years to come, making this strategy critical to decarbonization.

Addressing Equity

This strategy encourages several efforts to remove barriers to local renewable energy development, including providing trusted information on renewable energy options and lowering upfront costs. Community solar and community choice aggregation can provide access to affordable renewable energy to all community members, including renters.

Howard County Leading by Example

Howard County has always been a leader in adopting solar on County-owned properties. In the last decade, Howard County installed solar on rooftops, canopies over parking, and even over a retired landfill. In 2020, Howard County government entered into the largest solar Power Purchase Agreement (PPA) in the state of Maryland. By aggregating rooftop, parking canopy, and ground-mount projects from public and private sites into one agreement, Howard County was able to meet multiple needs while keeping the cost of electricity down – even saving money compared to its already low group purchase rate. When complete, the combined projects are expected to generate a monumental 44 million kilowatt-hours of electricity each year. This will provide well over half of the total electricity needed for County government operations.

In addition, Howard County has made it easier for its residents and businesses to adopt solar. Following an investigation of solar policy through its 2020-21 Solar Energy Task Force, Howard County passed a comprehensive Zoning Regulation Amendment that opened more zoning districts to solar development, streamlined the zoning application process for personal and commercial use solar facilities, and better aligned the policy on commercial solar facilities on Agricultural Land Preservation Program properties to support farmland, farmers, and community solar projects. Howard County also began offering more Payment in Lieu of Taxes (PILOT) agreements to reduce the tax burden on solar developers and property owners.

GHG Emissions Reductions		Cost Considerations	Co-Benefits
2030 708k $MTCO_2e$ 16% reduction from 2005 baseline	2045 969k $MTCO_2e$ 24% reduction from projected 2045 emissions	High upfront costs; lower energy costs over time	This strategy will increase equity in the renewable energy marketplace by placing emphasis on access for underserved communities through a low income carve-out for community solar projects.

Action 1: Expand the development of solar energy for residential, commercial, and government properties.

This action aims to increase the development of local solar installations on residential, commercial, and government properties, leveraging both new and existing policies and programs. This action promotes the transition to local renewable energy and reduces stress on the electricity grid, improving local and regional resilience to power outages caused by high electricity use. Howard County can encourage and promote onsite solar deployment and can help ensure equitable access. The County also can provide unbiased solar information to homeowners and businesses and can help drive down the upfront costs of solar. For any situations where on-site solar is not possible, Howard County can promote community solar and 100% renewable third party electricity suppliers as another way to decarbonize the grid.

Overcoming Barriers

Upfront costs to property owners and knowledge about how to navigate onsite solar installations are major hurdles. Additionally, coordination across County departments will be crucial to create a more streamlined permitting process.

Tracking Progress

This action seeks to increase rooftop, carport, and ground mount solar capacity installed in Howard County. To determine the potential for local solar generation, Howard County estimated the maximum capacity of new solar that would be technologically feasible to add to residential and commercial rooftops within County boundaries. For a solar rooftop installation to be technologically feasible, the roof typically needs to be less than 5 years old, have the structural capacity to bear the weight of the solar array, and get adequate sunlight, among other factors. Other variables such as cost and consumer preferences were not considered relevant to technical feasibility. Understanding that costs and consumer preferences can also impact whether solar installations move forward and understanding that some property owners may choose to install solar canopies over parking or ground mount solar arrays, the County based its goals for solar installation on achieving 90% of the technologically feasible potential for rooftop solar. This means that in 2030, the technologically feasible potential for rooftop solar in Howard County will be 1,217 MW DC. The County's goal for that year is to reach 36% of that potential, which is 437 MW DC. In 2045, technologically feasible potential for rooftop solar was adjusted for population growth and associated new buildings, bringing the new rooftop solar potential to 1,259 MW DC. The County's goal for 2045 is to reach 90% of that potential, which is 1,133 MW DC. Although solar installations on 90% of the technologically feasible rooftop space available in Howard County in 2045 may seem like an aggressive goal, it assumes that while the actual rate of solar rooftop installations may be less than 90%, the MW DC capacity will be made up through installations of solar canopies over parking and ground-mounted solar arrays.

In the last three years, new solar installations in Howard County have averaged about 15 MW DC capacity each year. To put this action into perspective, it seeks to increase new solar installations by a factor of 3, reaching approximately 45-47 MW DC capacity of new solar installed in Howard County each year. However, it is likely that this increase will begin

gradually and then increase more exponentially in future years as new policies, education and outreach efforts, and incentives for solar become available.

In any cases where on-site solar isn't possible, Howard County seeks to increase participation in community solar, renewable electricity suppliers, and renewable energy credits. While a reliable baseline for the percentage of residential and commercial properties in Howard County that participate in these programs was not available at the time of this report, one of the implementation steps under this action is to establish a baseline and to continue measuring progress to reach the stated goals below.

Metric	Baseline	Goal
Installed solar capacity (combination of rooftop, ground-mount, and parking canopy)	108 MW DC	437 MW DC – enough to power 50,700 homes (2030) 1,133 MW DC – enough to power 131,500 homes (2045)
Participation in community solar and/or other renewable energy supply and Renewable Energy Credit options.	Unknown	50% of residential and commercial properties in Howard County (2030) 100% of residential and commercial properties in Howard County (2045)

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer for this action, with support from Department of Planning and Zoning (DPZ), Department of Inspections, Licenses, and Permits (DILP), and Department of Public Works – Facilities (DPW Facilities).

Next Steps	Timeline	Responsibility
Continue to install solar on County government facilities whenever possible, especially for new construction, roof replacements, and in conjunction with parking lot and parking garage construction. Incorporate a solar feasibility review into new construction and renovation projects greater than 10,000 GSF for County government facilities. Pursue grants, incentives, power purchase agreements, and other opportunities to reduce costs of solar installation.	2023-onwards	DPW – Facilities, OCS
Purchase Renewable Energy Credits as needed, and as funding is available, to offset GHG emissions from electricity used to power County government operations.	2023-onwards	OCS
Work with community partners such as HCPSS, Howard Community College and others to encourage the installation of solar on rooftops, parking lots, and on suitable land wherever possible, especially during new construction. Provide information to these partners on grants, incentives, and other opportunities to reduce costs of solar installation.	2023-onwards	OCS
Explore options for a non-government organization, such as a green bank, to support the clean energy marketplace through financing, marketing, and technical support to help remove barriers to clean energy investments.	2023-2025	OCS
Research best practices and identify any additional needs to modify codes and/or permitting and zoning to maximize implementation of onsite solar and battery storage. Options may include requiring new residential construction to include solar ready roofs and south-facing roofs, for example.	2023-2025	DILP, OCS, DPZ

Ensure flexibility in zoning that promotes the installation of onsite solar by residents and businesses as part of future zoning code updates.	2023-2025	DPZ
Consider development of policy guidance on when and how Payment in Lieu of Taxes (PILOT) agreements may be offered to reduce costs of large solar installations.	2023-2024	OCS
Promote existing solar co-ops and or work with partners to create new solar co-ops as needed to reduce installation costs and increase the number of Howard County homes that have onsite solar power.	2023-2024	OCS
Determine current participation of Howard County residential and commercial properties in community solar, third-party electricity suppliers that provide 100% percent renewable energy, and/or that purchase Renewable Energy Credits to offset GHG emissions of their electricity use. Continue to monitor participation annually to track progress.	2023-onwards	OCS
Create educational materials and outreach programs for residents and businesses on technical assistance, incentives, and other useful information to promote the use of onsite solar, community solar, and purchases of 100% renewable energy from third party suppliers with special emphasis on underserved communities. Also provide information on Renewable Energy Credits as an option for businesses and nonprofits as another option to reduce GHG emissions from electricity use.	2023-2024	OCS
Consider additional options to increase renewable energy use in Howard County, such Community Choice Energy, which would provide a renewable energy supplier as the default for all residential and commercial electricity accounts, with the ability to opt out. (Currently, the default is the utility standard offer of service. Individual customers have the option choose a different supplier. However, each customer must conduct their own research to choose a supplier, typically with limited information. Renewable energy suppliers are included among many other, less climate-friendly options).	2024-2025	OCS

Transportation

Strategy T1: Maximize the Use of Electric Vehicles

Electric vehicle adoption should be increased in the public and private sector. This strategy works in tandem with grid decarbonization strategies, as the electricity used to charge EVs becomes cleaner over time.

Electric vehicles currently make up only 1% of vehicles registered in Howard County. In addition, only a few of Howard County's government fleet and school buses are currently electric. Howard County has made progress with including hybrid vehicle and replacing *inefficient* vehicles with lower-emission ones, but there is still great potential to reduce GHG emissions through increased EV adoption and use. This strategy advances EV charging infrastructure, encourages private EV purchases, and converts school and transit vehicles to electric. Through implementation of this strategy, Howard County will:

- Accelerate the conversion of the government fleet to electric vehicles.
- Accelerate the conversion of the County's transit and school bus fleets.
- Promote the adoption of electric vehicles among residents and businesses.

Why These Actions?

Transportation represents the largest source of GHG emissions within Howard County. Increasing the adoption of EVs in the public and private sector has the potential to reduce these emissions, both within the community at large and within government operations. This is the single most impactful action to reduce the County's footprint.

Addressing Equity

Although EVs have great potential to reduce emissions, they are currently more expensive than internal combustion engine vehicles and used EVs are not always available. Conscious effort must be made to design and promote incentive programs and charging infrastructure projects that directly benefit low-income residents.

Howard County Leading by Example

Howard County government has already taken steps toward addressing vehicle emissions by adopting a Green Fleet Policy in 2020. The policy addresses reducing idling, increasing fuel efficiency, right sizing the fleet, and purchasing electric vehicles. Approximately 25 percent of the Howard County government fleet already is either electric or hybrid, including public safety and administrative vehicles, with plans to continue replacing aging fleet vehicles with electric or hybrids whenever possible. Howard County also has significantly increased the availability of electric vehicle charging stations for fleet vehicles, employees, and the public by adding 62 new charging stations at more than a dozen County facilities over the past four years.

<table>
<tr><th colspan="2">GHG Emissions Reductions</th><th>Cost Considerations</th><th>Co-Benefits</th></tr>
<tr><td>2030
207k $MTCO_2e$
5% reduction from 2005 baseline</td><td>2045
1,137k $MTCO_2e$
28% reduction from projected 2045 emissions</td><td>Upfront cost premium for electric vehicles. Ongoing fuel cost savings, as EVs are more efficient.</td><td>Increased EV adoption reduces air pollution and associated health impacts.</td></tr>
</table>

Action 1: Continue to develop a robust EV charging station infrastructure.

As of 2022, 62 chargers have been installed on Howard County government property, a 450% increase from the pre-2019 number of 12. When including chargers by the private sector, this total comes to 117, as indicated by the AFDC Electric Vehicle Charging Station Locations.[27] As of 2019, all new residential construction with driveways or garages are required to have the electric wiring to enable electric vehicle charging and new multi-family residential buildings must provide EV chargers.

This action supports even more robust expansion of charging stations in the County to encourage the adoption of electric vehicles. Modeling developed by Javid et al. 2019[28] shows that publicly available chargers are positively correlated with EV adoption. This model was applied to Howard County to estimate EV uptake from initiatives that increase publicly available chargers. The model considers demographics, home ownership, gas prices, electricity prices, average commute time, and the number of chargers per 10,000 residents to estimate EV uptake. Other studies also indicate that increasing the number of publicly available charging stations can lead to increases in electric vehicle adoption.[29, 30] Publicly available chargers can include charging stations at Howard County government facilities such as parks, libraries, and offices as well as charging stations at workplaces, shopping centers, and along interstate corridors. While the modeling used for this document assumed level two charging stations with two charging ports per station, research also points to lower cost, yet also promising options, such as adding more level one charging stations and/or outdoor 120-volt outlets as workplace

charging.[31] This slower charging option could work well for employees to plug in and charge throughout the workday and can even provide opportunities for nearby apartment or townhome dwellers to charge overnight.

Overcoming Barriers

Increasing the number of publicly available charging stations reduces "range anxiety", a common barrier to electric vehicle adoption. Even with larger ranges in newer EV models, people feel more comfortable driving an EV if they know they have the option to charge the vehicle at multiple, convenient locations. As more people drive EVs, more charging stations will be needed to support these vehicles.

Tracking Progress

The objective of this action is to significantly increase the number of publicly accessible charging stations in Howard County. This in turn will encourage greater adoption of electric vehicles by County residents and commercial fleets.

Metric	Baseline	Goal
Number of EV Charging Stations in Howard County	117 charging stations (Countywide)	400 charging stations (2030) 2,600 charging stations (2045)

Implementation

The Office of Community Sustainability will lead on outreach, grants, and partnerships. Department of Public Works, Bureau of Facilities will lead on EV infrastructure installs. The two agencies will continue to coordinate on policy and planning. Additional planning assistance will come from the Office of Transportation, Office of Central Fleet Administration, and Department of Planning and Zoning.

Next Steps	Timeline	Responsibility
Implement programs to educate the public about home charging and public charging station information such as location, cost to charge, and how to use the stations. Leverage existing outreach materials and public charging locator mobile apps as well.	Ongoing	OCS
Evaluate the reliability of chargers installed on Howard County government property, report any reliability problems and work to get them fixed.	2023	OCS, DPW Facilities, BGE
Identify geographic areas with low charger density relative to population density and develop a plan for near-term charger deployment in those areas, including installation of charging stations on public and private property.	2023-2024	OOT, DPW Facilities, OCS
Identify barriers to installing EV charging in multi-family housing. HOAs and condos have cost barriers as well as permitting barriers. Continue to partner with BGE and support their multi-family pilot project.	2023-2025	DILP, OCS, DPZ
Prepare a short and long-term plan for charger deployment, estimating future needs. Work with state and regional planning agencies and seek funding for the next phase of chargers. State and Federal efforts currently focus more on highways and higher use roads. Local government, utilities, and the private sector can partner to address charging needs at the more local level.	2023-2024	OCS, OOT, DPW Facilities
Proactively address any power requirements for new charging stations, such as needs for new service lines from the utility or installation of transformers, to avoid any delays due to the significant lead times required to order and install this equipment.	2023-2025	DPW Facilities, BGE

Install additional chargers within the County. Support Howard County Public School System efforts to install chargers at school properties. Leverage partnerships such as the BGE EVSmart program and grants to fund new chargers, such as through MDOT, MDE, MEA and federal Inflation Reduction Act opportunities.	2023-2030	OCS, HCPSS, DPW Facilities, BGE
Work with non-government entities such as businesses and nonprofit organizations to identify appropriate charging station locations and help these entities apply for funding and rebates to subsidize the costs of new charging station installations. Also explore options for installing low-cost level one charging options where useful, such as at workplaces where employees can charge all day and nearby residents could charge at night.	2023-2030	OCS

Action 2: Accelerate the adoption of electric vehicles in the community and County government fleet.

With EVs at only 1% of vehicles registered in Howard County, there is a long way to go to achieve wide-spread EV use. This action seeks to increase the rate of EV adoption in the community and the County government fleet. Under this action, the County will pursue an accelerated schedule for replacing County vehicles with electric vehicles. Outreach programs will encourage EV adoption among the community by helping to reduce barriers to EV purchase and use.

Overcoming Barriers

Barriers to widespread adoption of EVs include their higher up-front cost, concerns about range and ability to charge easily when away from home, a lack of understanding about the benefits of EVs, and confusion about available rebates. Medium- and heavy-duty utility EVs have only recently entered the market and are not yet available for all vehicle types. Recently, there also have been challenges acquiring EVs due to supply chain issues and high demand.

Tracking Progress

Under this action, the County will pursue an accelerated schedule for replacing County vehicles with electric vehicles. Other County programs will seek to encourage additional EV adoption among the community by helping to reduce barriers to EV purchase and use. The metric is defined for passenger cars, including coupes, compacts, sedans, and station wagons. It is also defined for passenger trucks, which are light-duty trucks that include pickups, sport utility vehicles (SUVs), and vans. These vehicle types have separate metrics because of the differences in emissions and availability of EV models between the two.[32]

Metric	Baseline	Goal
Number of all electric plug-in vehicles (EVs) in the government fleet	7	578 (2030) (42%) 1,336 (2045) (100%)
Percentage of EVs owned by people, businesses, and government in the County	1%	26% passenger cars, 8% passenger trucks (2030) 85.5% passenger cars, 73% passenger trucks (2045)

Implementation

The Office of Central Fleet will be the lead implementer for this action, with support from the Office of Community Sustainability.

Next Steps	Timeline	Responsibility
Promote federal, state and utility rebate programs for low/no-carbon fuel vehicle purchase by the public.	Ongoing	OCS
Implement an education and outreach program for the community about EVs, how they work, and their benefits. Conduct peer-to-peer and social marketing outreach.	2023-2025	OCS
Conduct outreach regarding installing home charging including rebates and vetted contractors if possible.	2023-2025	OCS
Seek technical assistance from Maryland Energy Administration toward development of a fleet electrification plan for Howard County government.	2023	Fleet, OCS
Make a short and long-term plan for EV fleet adoption, including funding needs to cover incremental costs of EV options over petroleum fuel vehicles. Pursue state and federal funding wherever possible and request funding in the County budget as needed to cover any gaps.	2023-2030	Fleet, OCS
Research electric and other low GHG emitting options for medium- and heavy-duty vehicles, including retrofit and add-on technology such as zero RPM battery systems to reduce engine idling in ambulances, snowplows, and other vehicles that need constant heat, air conditioning, and auxiliary power. These options can help reduce emissions from these vehicles while appropriate all electric alternatives are developed.	2025	Fleet, OCS

Action 3: Transition to a zero-emissions transit vehicle fleet.

This action will convert transit buses serving Howard County to a low/no-emission option, with a particular focus on EVs. Howard County will develop and implement a transition plan to zero emission buses. The transition plan will determine the feasibility, cost, and timeframe for a conversion of the fleet. To bridge the gap in the near term, other low-emission technologies, such as clean diesel, clean natural gas, and renewable natural gas, may be employed.

Approximately 15 bus routes operate within Howard County. Three Central Maryland Regional Transportation Agency (RTA) buses are fully electric, with plans for more in the future. As a near-term solution, Howard County also has had success in significantly reducing air pollution from transit buses through the use of clean diesel. While only moderately effective for GHG emissions reduction compared to electric buses, the clean diesel buses decrease particulate matter, NOx, and other air pollutants that impact human health, especially in underserved communities.

Overcoming Barriers

Careful planning and study of potential replacement vehicles must be conducted to ensure that they can match the endurance requirements for specific routes. Considerations also must be made to install appropriate charging and refueling infrastructure at strategic locations.

Tracking Progress

The objective of this action is to convert the Howard County RTA public transit fleet to electric buses by 2045.

Metric	Baseline	Goal
Number of EV buses, cutaways, and automobiles used for passenger services in RTA's fleet	3 (4%)	40 (48%) (2030) (FY25-FY30 plan) 82 (100%) (2045)

Implementation

The Office of Transportation will be the lead implementer for this action in conjunction with the RTA that serves as a Contractor to the County. Department of Public Works (DPW) also will assist.

Next Steps	Timeline	Responsibility
Develop a transition plan to zero emission buses. The transition plan will determine the feasibility, cost, and timeframe for a conversion of the fleet. Identify tradeoffs of several low/no emissions technologies, including renewable/biodiesel, CNG, hydrogen, and battery electric. Consider the medium term and long-term benefits of each solution and prioritize using a combination that moves towards no-emission vehicles.	2023-2025	OOT, RTA
Pursue State and Federal funding to support new transit vehicle purchases.	2024-2025	OOT, RTA
Identify and implement fast charging stations at locations along transit lines.	2025-2035	OOT, DPW
Deploy charging/fueling infrastructure at bus yards.	2025-2035	OOT, DPW
Purchase replacement transit vehicles following the transition plan.	2025-2045	OOT

Action 4: Transition to a zero-emissions school bus fleet.

Howard County Public School System (HCPSS) uses over 500 school buses to transport elementary, middle, and high school students to and from school. Replacing fossil fuel powered buses with electric buses as they reach the end of their useful life would result in significant GHG emissions reductions. Under this action, HCPSS will create and implement a plan to transition buses to electric.

Overcoming Barriers

Howard County Public School System (HCPSS) has significant obstacles to converting buses to electric since bus service is contracted out to private companies and the buses are not owned by the County. However, HCPSS is in the process of revising school bus policies and contracts and may be able to take this opportunity to push for school bus conversion. School buses usually make a minimum of 6 runs per day, two each for elementary, middle, and high school. Therefore, EV bus range and fast charging infrastructure will need to be carefully considered. Finally, electric buses currently cost significantly more than fossil fuel powered buses, and there will be costs for needed charging infrastructure as well. However, there are several federal and state grants available to assist school districts with school bus electrification that may help reduce this barrier. HCPSS will need very significant support and funding to make converting school buses to electric a reality.

Tracking Progress

The objective of this action is to reach 100% conversion to electric school buses by 2045 based on a 10-year replacement schedule.

Metric	Baseline	Goal
Number of electric school buses	2 (0.4%)	393 (73%) (2030) 535 (100%) (2045)

Implementation

Howard County Public Schools Transportation Department will be the lead implementer for this action, with support from Office of Community Sustainability. Budgets are determined by the School Board.

Nest Steps	Timeline	Responsibility
Develop a timeline for adoption of electric buses, taking into consideration that most school buses are contracted, not owned, by the school system.	2023-2024	HCPSS
Develop policies for contracting that incentivize EV adoption.	2023-2025	HCPSS, OCS
Investigate moving toward HCPSS owning and operating some portion of the bus fleet.	Ongoing	HCPSS
Request funding in the HCPSS budget and pursue grant funding and incentives for electric bus purchases.	2023-2030	HCPSS, School Board

Strategy T2: Reduce Vehicle Miles Traveled in Single Occupancy Vehicles

Howard County had the fifth highest vehicle miles traveled (VMT) in Maryland in 2019. High VMT contributes to transportation being the largest source of GHG emissions within Howard County. Opportunities to lower VMT include expanding transit options and reliability, increasing transportation connections from homes to jobs and amenities, expanding non-motorized transportation options, increasing telework opportunities, and encouraging behavior changes. Expanding transit access has the additional benefit of improving equitable access for those with few mobility options. Through this strategy, Howard County will:

- Expand transit coverage and increase the level of service across Howard County.
- Expand walking and biking infrastructure.
- Encourage alternatives to commuting and driving.
- Encourage behavior changes such as trip chaining, carpooling, and reduced idling.

Why These Actions?

Although EVs reduce emissions, they do not eliminate them. Increased use of public transportation and shifting to walking and biking will further reduce emissions from transportation. Safe, comfortable, and low-stress infrastructure is critical to encouraging more walking and biking. The pandemic has shown that teleworking is possible for many occupations. Even though telecommuters may run more errands during the day close to home than they did while commuting to the office daily, reductions in driving through teleworking can still lead to substantial net emissions benefits. Additional behavior changes, like reducing idling, carpooling, and grouping trips together can further reduce VMTs and related emissions.

Addressing Equity

Transportation disadvantaged communities should be prioritized for pedestrian infrastructure improvements. Microtransit service areas should be selected to benefit transportation disadvantaged communities wherever possible. Lastly, it is important to consider that many low-income occupations are not telework-capable, and these positions should not be disproportionately impacted by travel costs.

Howard County Leading by Example

Howard County offers free Regional Transit Agency (RTA) bus access to middle and high school and Howard Community College students. People who are age 60 or older or who have a disability can ride the bus for free. Howard County also offered free bus fares to all passengers in September and October 2022. Howard County government offers the majority of employees flexible telework options and has implemented extensive use of teleconferencing and remote work tools to reduce the need for transportation to in-person meetings.

GHG Emissions Reductions		Cost Considerations	Co-Benefits
2030 187k $MTCO_2e$ 4% reduction from 20005 baseline	2045 254k $MTCO_2e$ 6% reduction from projected 2045 emissions	Upfront Costs: Infrastructure costs for microtransit and other infrastructure Ongoing Costs: Maintenance	Increased physical activity from walking and biking improves health and well-being. New transit services improve quality of life of community members by offering greater mobility.

Action 1: Increase public transit ridership by enhancing the effectiveness and reliability of local and regional public transit.

Public transit can be an effective way to reduce vehicle trips. Opportunities to increase local and regional transit frequency and reliability should be evaluated and implemented where ridership has the best chance of being increased. Outreach about how to use public transit can also help to increase its use.

Overcoming Barriers

Howard County is a primarily suburban and rural county, with a few town center areas and other hubs of activity. This makes it very challenging to plan public transit routes that will serve the largest number of people in a cost-effective manner.

Tracking Progress

The objective of this action is to increase ridership on Howard County's public transit system.

Metric	Baseline	Goal
Number of local public transit trips taken each year	640,000 (demand-responsive and fixed-route)	1,000,000 (2030) 1,300,000 (2045)

Implementation

The Office of Transportation will be the lead implementer for this action in coordination with the Regional Transit Agency (RTA) and Maryland Transit Administration (MTA).

Next Steps	Timeline	Responsibility
Continue to plan and implement public transit service expansions and frequency improvements in the RTA service area and on the high priority corridors identified in the 2023 Transit Development Plan and the Regional Transit Plan, including extending Montgomery County's Flash Bus Service to Downtown Columbia	Ongoing	OOT, RTA
Increase reliability of RTA transit service	Ongoing	OOT, RTA
Work with MTA and other transit stakeholders on the MARC cornerstone plan to expand service and improve reliability on the CSX Camden Line	2023-2025	OOT, MTA

Explore creation of an autonomous Downtown Shuttle in partnership with Howard Hughes, DTC Partnership and others with funding to support such an initiative	2024-2030	OOT

Action 2: Implement microtransit in less dense areas that have a demonstrated need of connection between homes, jobs, and services.

Microtransit is an on-demand, flexible transit mode that can provide a higher level of service than fixed route transit in certain contexts. Opportunities to apply this in Howard County should be examined. Through this action, Howard County seeks to implement a microtransit system by 2030. Microtransit enables more user-specific access and acts as a public and less expensive alternative to ride-hail services.

Overcoming Barriers

One of the biggest challenges to increasing public transit use and reducing vehicle miles traveled is what is known as the first mile/last mile problem. This refers to the distance a commuter needs to travel from a transit stop to their destination or vice versa. Transit stops typically provide transportation only to and from fixed, high traffic locations, which requires many commuters to walk a greater distance than feels comfortable to them to get to or from the transit stop. Adding enough transit stops to reduce the walk distance for most potential commuters isn't practical or affordable. Microtransit can offer these connections to scheduled transit in an affordable, flexible, on-demand manner that can meet the needs of many more potential transit riders. It also can offer more mobility options for people without personal vehicles, especially for shorter trips.

Tracking Progress

The objective of this action is to replace vehicle miles traveled (VMT) from single occupancy vehicles with on-demand, flexible microtransit. A pilot project will be implemented and assessed to determine goals and metrics.

Metric	Baseline	Goal
Microtransit ridership	0	TBD based on pilot (2030) TBD (2045)

Implementation

The Office of Transportation (OOT) will be the lead implementer for this action.

Step	Timeline	Responsibility
Research opportunities and regions within Howard County that could potentially benefit from microtransit.	2023-2025	OOT
Conduct microtransit pilot in the US Rt 1 corridor and assess ridership after one year of operation.	2024-2025	OOT
Based on results of the US Rt 1 pilot, expand microtransit service into areas with the greatest need for additional public transit options.	2025-2030	OOT

Action 3: Expand and improve sidewalks, crosswalks, pathways, and bike lanes and connect them to jobs, shopping, schools, and recreational amenities.

This action will improve and expand bike and pedestrian infrastructure to provide safe, comfortable, and effective walking and cycling options that can replace vehicle miles traveled, especially for shorter trips. This action also includes

education and outreach programs to raise awareness of existing and new sidewalks, crosswalks, pathways, and bike lanes, how to navigate them and plan trips using them, and how to use bicycles for commuting and recreational travel.

Overcoming Barriers

There currently are gaps in Howard County's walking and cycling infrastructure network that make some trips challenging. In order to increase walking and cycling and to keep pedestrians and cyclists safe, it is important to close any gaps in the walking and cycling infrastructure network, taking equity into consideration. This can be accomplished by prioritizing projects in areas where a higher share of residents belong to racial and ethnic minorities, have lower incomes, have fewer cars per household, are disabled, have limited English proficiency, and are older. Traditionally, these communities have been left behind in the development of new pedestrian infrastructure.

Tracking Progress

The objective of this action is to reduce VMT by shifting short trips to walking, biking, and electrified micromobility modes, such as electric bicycles or scooters.

Metric	Baseline	Goal
Increase in bike lane miles	76 miles	Increase 20% by 2030 Increase 40% by 2045
Increase in sidewalk miles	1076 miles	Increase 2% by 2030 Increase 4% by 2045

Implementation

The Office of Transportation will be the lead implementer for this action. Department of Public Works (DPW), Howard County Police Department (HCPD) and Maryland Department of Transportation (MDOT), and Office of Community Sustainability (OCS) have support roles.

Next Steps	Timeline	Responsibility
Review and update existing plans to grow pedestrian/bicycle infrastructure and conduct outreach to identify new routes, improvements, and micromobility offerings.	2023-2025	OOT
Continue to integrate identified improvements into the design and construction of low stress pedestrian and bicycle infrastructure with an emphasis on the high-quality designs articulated in the County complete streets policy and design manual.	2023-2030	OOT, DPW, MDOT
Continue to advance and implement education and enforcement materials and programs to enhance and improve the safety of the transportation system for pedestrians and cyclists.	2023-2030	OOT, DPW, HCPD, MDOT
Incentivize the purchase and use of bikes, including electric bikes. Research state and federal and private funding opportunities.	2023-2025	OOT, OCS

Action 4: Increase and normalize teleworking options for employees whenever possible.

Telework reduces the number of commuters on the road, which can ease congestion and reduce overall VMT. For example, 950 Howard County government employees teleworking 77 working days during the first three months of the COVID-19 pandemic travelled 2 million fewer miles, saved 95,850 gallons of gasoline, and reduced GHG emissions by 852 metric tons CO_2e. Teleworking can have other benefits as well. According to the International Telework Association and Council, teleworking can increase employee productivity more than 20% and decreases employee absenteeism 60%.

Information from the Maryland Department of Labor and from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics indicate that more than half of the jobs in Howard County could be telework capable. However, only just over 20% of workers in Howard County currently work from home at least one day per week. This action will encourage the implementation and/or continuation of full or hybrid telework environments for all occupations that can support telework.

Overcoming Barriers

Not all jobs are work-from-home capable. Implementation of this action should be sensitive to the impact on jobs that do not allow for telework. While research[33] has shown that employees who telework tend to drive more miles for non-work-related purposes during telework days than during commute days, the increase in VMT from telework is minor in comparison to the VMT reductions achieved from even two or three days a week of telework for most or all telework capable jobs.

Tracking Progress

The objective of this action is to reduce VMT by eliminating commute trips.

Metric	Baseline	Goal
Number of employees Countywide who work from home at least one day per week and percentage of total workforce.	38,000 (23%)	70,800 (40%) (2030) 105,000 (52%) (2045)
Avoided commuter trips in miles, assuming 3 days worked from home per week	143.2 million mi	266.7 million mi (2030) 395.6 million mi (2045)

Implementation

Howard County Administration (County Admin) will be the lead implementer for this action, with support from Human Resources (HR), Economic Development Authority (EDA), Office of Transportation (OOT) and Office of Community Sustainability (OCS).

Next Steps	Timeline	Responsibility
Support telework adoption by providing guidance and carbon emissions impact to employers. Guidance can include draft telework policies, case studies of effective programs, and networking opportunities among human resources personnel to facilitate sharing of best practices.	2023-2024	County Admin, HR, EDA
Connect businesses in Howard County with existing federal and state grant opportunities to purchase equipment, software, and access technical assistance and other resources to initiate or expand telework programs.	2023-onward	OCS, EDA
Consider new tax incentives, grants, and/or recognition programs for local employers with workers that offer a hybrid work schedule and report to the County on person days of telework and/or avoided commuter miles.	2025	EDA, OOT, OCS

Action 5: Implement policies, outreach programs, and incentives to promote individual behavior changes to reduce emissions from personal vehicles.

Individual behavior change can be difficult, but since transportation is the largest source of GHG emissions in Howard County, we must use all the options available to us to reduce vehicle miles traveled. Behavior changes such as trip chaining, carpooling, and reducing idling are very low-cost ways to reduce VMT and to reduce costs for individual drivers.

Overcoming Barriers

Many drivers may be unaware of how much gasoline they can waste idling or through poor trip planning. Howard County can address this lack of awareness through public outreach efforts. In addition, there are tools to assist with trip planning to optimize routes and optimize fuel efficiency. Such information often is readily available through popular mapping apps. While finding people to carpool with can be a challenge for individual drivers, there are regional programs that pair commuters with others going to and from the same places. Howard County's outreach efforts can help drive additional participation in these carpool matching programs.

Tracking Progress

The objective of this action is to increase positive driver behaviors that reduce VMT and GHG emissions. Progress will be tracked through the number of people reached through webpages, social media posts, newsletter opens, webinar attendance, and other outreach methods.

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer for this action, with support from the Office of Transportation (OOT), Department of Public Works (DPW) and Howard County Public School System.

Next Steps	Timeline	Responsibility
Work with schools to increase the ability to walk and bike to school and reduce the number of parents driving students to school. Increase infrastructure such as paths and bike racks.	2023-2025	HCPSS, OOT, DPW
Conduct outreach campaigns to encourage behavior changes like trip chaining, carpooling, and reduced idling.	2023-2025	OCS, OOT
Research coordinated carpooling options and rides home from work programs and increase awareness about them. Promote existing apps and tools to connect carpool partners and/or research options for developing new tools as needed.	2023-2025	OCS, OOT

Waste

Strategy W1: Reduce Organic Waste Sent to Landfills and Manage Landfill Methane

Organic waste in landfills is a significant source of methane generation and subsequent emissions. Diversion techniques such as composting organic waste can reduce methane generation. Ensuring that methane generated in landfills is captured and managed using best practices is also very important.

Methane has more than 25 times the global warming potential of carbon dioxide. Therefore, it is critical to reduce methane emissions wherever possible. A Howard County study showed that organic waste makes up 30 percent of the local municipal solid waste stream. Diversion techniques such as composting organic waste can reduce methane generation in landfills. Howard County only has one active landfill, so most of its municipal solid waste is sent out of County. Although many GHG emissions inventories would not count emissions generated outside of the jurisdiction, Howard County did include all landfill emissions in our inventory, including those generated from out of County landfills that accept Howard County waste. Through implementing this strategy, Howard County will:

- Expand composting programs for the residential sector and increase participation where the Feed the Green Bin program already exists.

- Increase composting by schools and other public sources of organic waste and decrease the amount of food waste created.
- Increase knowledge and use of home composting through outreach and working with community partners.
- Promote existing commercial composting options and investigate the long-term capacity needed to compost organic matter from private companies.
- Ensure that Howard County's Alpha Ridge Landfill and closed landfills meet or exceed the state and federal methane requirements.

Why These Actions?

Efforts to reduce the generation and disposal of organic wastes, such as food waste and yard waste, reduces methane generation. Further, composting local waste creates a circular economy – repurposing organic waste into useful products such as high-quality compost and soil amendments. Howard County has a composting facility at its Alpha Ridge Landfill. In 2019, more than 8,000 tons of organic waste was picked up from Howard County residents through curbside service and composted at this facility, reducing emissions by more than 4,000 metric tons of carbon dioxide equivalent (MTCO2e) Ensuring that methane generated in landfills is captured and managed using best practices is also very important, as this minimizes the amount of methane gases escaping into the atmosphere from landfills.

Addressing Equity

Not all residents currently have access to composting, although the highest-density neighborhoods were chosen first to participate in residential curbside composting collection. Expansion of the Feed the Green Bin program will allow more residents to have easy access to more composting options. Multi-family homes do not currently have the same composting options as single-family homes. New waste reduction efforts need to be applied more equitably to all residents.

Howard County Leading by Example

Howard County currently has a yard trim collection composting program that serves half of the homes in the County and focuses on food and yard waste. The "Feed the Green Bin" program expands on the yard trim collection by providing optional bins to add food waste collection. Feed the Green Bin is available to 35,653 homes—53% of the County's households with County service for yard trim collections. Alpha Ridge Landfill has a very high-tech and effective composting operation that produces high-quality products and has received certification of the U.S. Composting Council's "Seal of Testing Assurance." Howard County has a Feed the Green Bin website, a home composting education program, and gives out free home compost bins every year.

<table>
<tr>
<th colspan="2">GHG Emissions Reductions</th>
<th>Cost Considerations</th>
<th>Co-Benefits</th>
</tr>
<tr>
<td>2030
1.0k $MTCO_2e$
<1% reduction from 2005 baseline</td>
<td>2045
4.2k$MTCO_2e$
<1% reduction from projected 2045 emissions</td>
<td>Upfront Costs: Bin infrastructure, potential expansion of composting facility
Ongoing Costs: Waste collection, additional processing time</td>
<td>Produces a beneficial soil amendment that can reduce fertilizer application.</td>
</tr>
</table>

Action 1: Reduce organic waste and expand composting in the residential sector.

Howard County has a yard trim collection for most homes and an innovative Feed the Green Bin food waste collection program. This action will increase residential organic waste diversion by expanding residential access to the Feed the Green Bin program, increasing participation within existing collection areas, and promoting home composting and waste reduction.

Overcoming Barriers

Cost and composting facility capacity are barriers that currently prevent Howard County from offering the Feed the Green Bin curbside food waste collection program to all households. Howard County is working to expand capacity in order to offer curbside food waste collection to more households in the future. In the meantime, Howard County can increase participation in existing service areas through education and outreach activities. Some residences may be too remote for efficient pickup and these properties may be better suited for increased outreach and participation in home composting. Outreach programs can help individuals who are unsure about how to start home composting.

Tracking Progress

The objective of this action is to increase participation in curbside food waste collection and to maximize diversion of food and other organic waste from landfills.

Metric	Baseline	Goal
Households with access to the Feed the Green Bin program	35,653 (53%)	66,916 100% of County collection areas by 2030
Percentage eligible households participating in the Green Bin program (based on number of carts requested by households)	17,234 (48%)	75% participation of eligible households by 2030 90% participation of eligible households by 2045
Tons of food composted in the Feed the Green Bin program	660 tons (per year)	1,000 (2030) 2,600 (2045)
Residential yard trim composted	10,000 tons (per year)	Move towards more source reduction, less composting

Implementation

The Department of Public Works, Bureau of Environmental Services (BES) will be the lead implementer for this action.

Next Steps	Timeline	Responsibility
Increase education and outreach on reducing food waste, mulching leaves and grass on-site, and other methods of reducing the amount of organic waste created.	2023-2025	BES, OCS
Expand “Feed the Green Bin” service area to collect food waste from all residential areas that have yard trim collection.	Ongoing, expected completion 2026	BES
Investigate increased access by multi-family residences to composting pickup services. These homes are currently considered commercial and are not part of the County’s waste collection service.	Ongoing	BES
Increase education and outreach on composting including in multiple languages.	Ongoing	BES

Consider adding drop-off areas for residents outside of pick-up areas so they can participate. Residents can already bring organic materials to Alpha Ridge Landfill at no cost, but some residents may consider it too far from their home.	Ongoing, needs resources	BES
Continue to partner with local non-profit organizations and neighborhoods to increase participation in the Feed the Green Bin program and home composting.	Ongoing	BES
Continue educating the public on Food Waste Prevention. Increase awareness of the Food Waste Prevention website's resources such as food rescue apps, grocery planning, storage tips, and food donation. Consider adding more food waste challenges and other similar programs.	Ongoing	BES

Action 2: Incentivize businesses and schools to reduce organic waste and participate in composting.

Food waste can be a large portion of the waste stream for businesses and schools. This action encourages more local businesses and schools to reduce the creation of organic waste and increase composting. Currently seven schools in Howard County participate in the Feed the Green Bin program and Howard County has an online signup schools can use to be considered for the program. Some businesses and communities have had success with food donation and improving operations to avoid food waste. Howard County can build on these successes through education and outreach efforts, expanding composting services, and developing partnerships among businesses, schools, farms, and other key players in composting operations.

Overcoming Barriers

The main barriers to commercial composting are the lack of businesses accepting and processing these materials and the cost. The County's planned improvements to its composting facility will help increase capacity to manage organic waste in-County. Howard County's Feed the Green Bin website lists private companies that offer commercial composting. However, there is not currently enough capacity at this time to handle all the organic waste created. Howard County has a privately-owned biodigester that effectively manages commercial organic waste and creates marketable products. More local partnerships for the source material and end users of the products could make this a very viable option for increasing Howard County's organic waste recycling capacity. Composting efforts at schools and businesses are limited by cost, access to collection and training, and resistance to changing existing waste management practices. Increasing outreach and education to schools in particular and making it as easy as possible to join in can improve participation. While composting is very beneficial, more emphasis is needed on reducing waste before it becomes waste that needs to be managed.

Tracking Progress

The objective of this action is to increase the number of businesses and schools that participate in composting and food waste reduction programs.

Metric	Baseline	Goal
Schools participating in composting programs	7	30 (40% by 2030) All (2045)
School organic waste composted	36 tons per year	1080 (2030) 2880 (2045)

Number of commercial composting operations	1	2 (2030) 10 (2045)

Implementation

The Department of Department of Public Works, Bureau of Environmental Services will be the lead implementer for this action.

Next Steps	Timeline	Responsibility
Consider adding a composting certification category to the Work Green Howard program.	2024	BES
Investigate commercial composting by private businesses to find opportunities for the County to promote them and to help them expand.	Ongoing	EDA, BES, DPZ
Explore partnerships with farms to expand composting capacity for certain waste streams (e.g., wood debris from emergency weather events).	2023-2025	EDA, DPZ
Increase outreach to schools about the Green Bin program, encouraging them to sign up and participate.	2023-2025	BES, OCS

Action 3: Ensure that Howard County's Alpha Ridge Landfill and closed landfills meet or exceed the state and federal methane requirements.

This action reinforces that Howard County will continue to meet or exceed the state and federal landfill gas requirements. Howard County will also pursue innovative methane reduction technologies for landfills such as biofilters.

The state of Maryland is fairly aggressive in the proposal of new regulations to control methane from municipal solid waste landfills. As of February 2023, new regulations have been proposed and are receiving public comments. Howard County's Bureau of Environmental Services is following it closely.

Overcoming Barriers

Innovation can be a challenge in this very regulated area. In order to use new technologies, it must be approved by the State. Howard County will continue to pursue the latest technology in landfill gas management. Staff time and financial resources are needed to achieve these objectives.

Tracking Progress

Howard County is currently upgrading its enclosed landfill gas flare. The County monitors landfill gas, performs emissions testing, and submits compliance reports.

Implementation

The Department of Department of Public Works, Bureau of Environmental Services (BES) will be the lead implementer for this action.

Next Steps	Timeline	Responsibility
DPW-BES proposed an innovative treatment for landfill gas at New Cut Landfill to MDE in 2022 and received positive response from MDE. The landfill gas would be routed to a biofilter for treatment rather than the flare, which is currently more than 20 years old and operating on a timer. Construction of this treatment system could be done at relatively low cost and serve as model for other closed and small landfills in MD.	2023-2025	BES
Ensure that the methane collection system at Alpha Ridge Landfill meets or exceeds state laws and regulations.	Ongoing	BES

Strategy W2: Expand the Use of Sustainable Materials and Reduce Waste Generation and Disposal

This strategy focuses on identifying opportunities to reduce non-organic waste from Howard County sent to landfills. Adoption of sustainable government procurement practices can help Howard County government lead the way for the community to similarly identify opportunities to reduce waste.

Why These Actions?

Although difficult to quantify in a local GHG inventory, national and global GHG accounting shows that the amount of waste created per capita in the US contributes significantly to overall GHG emissions. Reducing waste at the source is the most cost efficient and impactful step we can take to reduce emissions from non-organic waste. In addition, this strategy focuses on reducing consumption of waste-heavy products like single-use plastics that generate GHG emissions in their production, transportation, and disposal.

Howard County excels in many environmental areas, as demonstrated by receiving LEED Platinum in 2022 in the LEED for Cities and Communities program. However, during the LEED certification process, gaps were also uncovered. The amount of waste generated per capita is high. (The other gaps revolved around transportation, another hugely important aspect of climate action).

Addressing Equity

Waste reduction efforts need to consider that alternatives to disposal products often have a higher upfront cost than their disposable counterparts. Howard County can address equity in this strategy by ensuring opportunities for people with lower incomes to obtain reusable alternatives at low or no cost. Limiting the use of plastic bags, cups, bottles, and other disposable products also helps reduce litter that often disproportionately impacts underserved communities. In addition to reducing these waste products at the source, Howard County also can sponsor cleanups in underserved communities.

Howard County Leading by Example

Howard County has implemented a plastic bag fee and a plastic reduction law that dis-incentivize using single-use plastic. Howard County also created the Plastic Reduction and Environmental Protection grant program that funds source reduction projects and education.

Action 1: Improve sustainable procurement in government operations.

This action will establish or expand the County government environmental procurement policy to encourage the purchase of sustainable materials and products and to minimize waste. Howard County should also consider life-cycle analysis and long-term benefits when evaluating procurements.

Overcoming Barriers

Government procurement is understandably risk-averse, so it can be difficult to change practices. Procurement may be an area of Howard County government that has not traditionally been included in sustainability discussions, but this needs to change. There also can be health concerns when hosting large public events outdoors on hot days without providing sources of water, which typically have been bottled water in the past due to lack of infrastructure such as water bottle filling stations.

Tracking Progress

The objective of this action is to reduce waste through County procurement policies. Howard County government has regulations about recycled content purchasing and environmentally preferable purchasing (EPP) but does not have formal, county-wide procurement policies that address waste reduction. The new goal should be to Implement waste reduction focused procurement policies for County construction activities, government events, and other purchases by 2025 as outlined in the Next Steps.

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer, coordinating closely with the Office of Procurement & Contract Administration (Procurement) and the Department of Public Works (DPW).

Next Steps	Timeline	Responsibility
Evaluate the procurement rules for construction to require construction waste recycling and reuse. This is currently done for LEED projects, but not others.	2023-2025	DPW, Procurement OCS
Evaluate construction rules and policies to allow greater re-use of construction waste such as asphalt and concrete.	2023	DPW, OCS
Research recognized procurement standards such as Forest Stewardship Council, GreenSeal, and Terracycle and adopt those that reduce waste.	2023-2024	Procurement, OCS
Have all departments use fewer single-use plastics in give-away items, plastic food ware, and plastic water bottles. Take a hard look at whether the expense and environmental cost are worth the disposable items commonly distributed.	2023-2024	Howard County Admin, Procurement
Invest in infrastructure to support the reduction of single-use plastic such as the installation of water bottle refilling stations.	Ongoing	DPW, DRP, HCPSS

Action 2: Reduce the use of single-use items, particularly plastics and promote waste reduction and reuse throughout Howard County.

Community outreach should increase focus on waste reduction, repair, and buying less. Howard County agencies should evaluate their operations looking for waste reduction possibilities and engage local partners to amplify waste reduction efforts and messaging. Howard County should seek to be a model in reducing waste, starting with events such as GreenFest.

Overcoming Barriers

Behavior change away from hyper-convenient, single-use products is a difficult challenge, but there is a large potential for improvement.

Tracking Progress

The objective of this action is to reduce single-use plastics through outreach and partnerships that compliment and amplify Howard County's enforcement of current laws. Howard County will continue to leverage and track progress made through the Disposable Plastic Bag fee initiatives.

Implementation

The Bureau of Environmental Services has an extensive outreach program for recycling. They can leverage these efforts to increase emphasis on waste reduction. All agencies should evaluate their operations looking for waste reduction possibilities. Howard County should engage local partners to amplify waste reduction efforts and messaging.

Next Steps	Timeline	Responsibility
Continue to implement and track source reduction practices as outlined in the Maryland municipal solid waste and recycling program.	Ongoing	BES
Continue to invest in infrastructure to support the reduction of single-use plastic such as the installation of water bottle refilling stations.	2023-2025	DRP, DPW, HCPSS
Increase education and outreach on reducing waste and its economic and climate action benefits.	2023-2025	BES, OCS
Support community partners such as the Community Ecology Institute, Repair Café, HC Library DIY center, Upcycled, and others that promote re-use.	Ongoing	OCS, BES

Nature Based

Strategy N1: Support Nature Based Climate Solutions to Improve Soil Health, Increase Carbon Sequestration, and Reduce Emissions

Conservation-focused practices that improve soil health reduce emissions to the atmosphere and increase carbon sequestration by minimizing soil disturbance while maximizing soil cover, biodiversity, and the presence of living roots. By focusing on soil health as a climate solution, we also gain co-benefits such as reduced soil erosion, improved water infiltration, increased nutrient cycling, decreased money spent on inputs like fertilizer, and more resilient soils over time.

Why These Actions?

Healthy soils sequester and retain greenhouse gases. Improving soil health also has many co-benefits.

Addressing Equity

Healthy, diverse ecosystems can improve climate resiliency across the community. Reduced mowing will lead to reduced noise pollution and improved air quality. Air pollution is often concentrated in underserved communities.

Howard County Leading by Example

Howard County has programs that address soil conservation, no-mow areas, meadows, and replacing turf with native plants and trees. These can be leveraged and expanded to have more climate action impact.

GHG Impacts

Achieving Howard County's GHG emissions reduction goals will require both reducing GHG emissions and sequestering more carbon. This strategy has components that do both. The actions under this strategy also have several economic and health co-benefits which should also be considered.

Action 1: Incentivize adoption of Natural Resources Conservation Service (NRCS) conservation practices that reduce GHG's and sequester carbon

Howard County provides agricultural technical assistance as well as cost sharing assistance from federal, state, and local sources for conservation practices. Under this action, the County will increase outreach and technical and financial assistance to farmers about practices that reduce soil erosion and create healthy soil.

Overcoming Barriers

Potential barriers to this action may include a lack of awareness about these conservation practices, a need for additional technical assistance, or a lack of funds to implement them.

Tracking Progress

As we begin to implement this strategy, we will gather baseline information and begin tracking metrics. We will track carbon sequestration from NRCS conservation practices, and we will work with the relevant County Departments to track the number of farms participating in incentive and financing options, Howard Soil Conservation District (HSCD) grants, and implementing agroforestry practices.

Implementation

Howard Soil Conservation District (HSCD) will be the lead implementer with outreach assistance from the Office of Community Sustainability (OCS), Department of Planning and Zoning (DPZ), and Department of Recreation and Parks (DRP).

Next Steps	Timeline	Responsibility
Utilize COMET-Planner to determine baseline carbon sequestration numbers and develop new incentive programs, or reevaluate existing incentives, to increase conservation practices.	2023- 2025	HSCD, OCS
Work with the relevant County Departments to get baseline number of farms participating in incentive and financing options, HSCD grants, and implementing agroforestry practices	2023-2025	OCS, HSCD, DPZ
Support grants to emphasize healthy soils practices implemented by farmers.	2023-2025	HSCD
Continue to work with farmers on healthy soils practices and implementing innovative solutions while promoting the financial, social, and environmental benefits of healthy soils.	2023-2025	HSCD
Work with farmers to better utilize and identify existing incentive programs and financing options.	2023-2025	HSCD
Research Climate Smart Agriculture to determine which practices can be better incorporated locally and pursue associated U.S. Department of Agriculture and associated financial incentives where appropriate.	2023-2025	HSCD, OCS
Research programs for farmers to sell carbon credits for best management practices.	2024-2026	HSCD, OCS

Work with farmers on implementing agroforestry practices such as silvopasture, riparian buffers, alley cropping, and windbreaks to increase tree plantings and forest cover. Develop educational materials for related best practices.	2023-2025	HSCD, DPZ, OCS
Consider utilizing DRP leased properties to serve as pilots for best management practices.	2023-2025	DRP

Action 2: Improve soil health on private lands through outreach and program expansion.

Native and deep-rooted plants sequester carbon and decompact soil to increase water infiltration and retention. Native plants are more adaptable to local weather patterns without additional water or fertilizer and they provide habitat. This action will encourage improving soil health through planting native plants and increasing sustainable landscaping practices on private lands.

Overcoming Barriers

Barriers to this action may include a lack of public awareness about the benefits of native plants and sustainable landscaping, stigmas for untidy looking landscapes based on social norms around mowed lawns, regulations and policies at the County and homeowner association level that discourage these practices, and lack of funds for implementation and maintenance of these practices.

Tracking Progress

As we implement this strategy, we will continue to track habitat registered through the Howard County Bee City Pollinator Habitat Registration as well as water quality practices installed that improve soil health.

Implementation

The Office of Community Sustainability (OCS) will lead the private property stormwater items and the Department of Planning and Zoning will lead on the Landscape Manual and Green Neighborhoods. The Department of Recreation and Parks (DRP) and Department of Public Works (DPW) are included for technical guidance and outreach assistance.

Next Steps	Timeline	Responsibility
Update the Howard County Landscape Manual to prioritize or mandate native plants and eliminate invasive plant species.	2023-2025	DPZ, OCS, DRP
Increase funding and staffing for private property stormwater programs to expand the installation of natural stormwater features on residential, commercial, and nonprofit properties that provide native habitats, soil retention, stormwater infiltration, and carbon sequestration.	2023-2025	OCS, DPW
Increase outreach to raise awareness about the private property stormwater programs and their reimbursement incentives, especially to low-income residents, and sites in vulnerable watersheds and underserved communities.	2023-2025	OCS, DPW
Reevaluate the Green Neighborhoods program to develop new incentives, reassess program potential and accessibility, and renew support. Or consider other programs to incentivize environmentally friendly, sustainable development.	2023-2025	DPZ, OCS

Establish a County-wide outreach campaign to educate the public about the value of soil health, native plants, no-mow areas, meadows, pollinator-friendly yards, using lawn mimics instead of traditional lawns, reduced chemical applications, and sustainable landscaping practices. Continue recognizing pollinator-friendly yards through the Bee City Campaign.	2023-2025	OCS, DRP

Action 3: Increase sustainable landscaping practices on public lands to improve soil health and reduce GHG emissions.

This action will encourage improving soil health through increased use of native plants and other sustainable landscaping practices on public lands. Additionally, reduced mowing on County land can reduce GHG emissions from lawn maintenance equipment. Howard County government should lead by example in their landscape practices, pilot new methods, and provide education to the public to implement them as well. Traditional landscaping equipment emits many GHGs. Reducing gas-powered equipment use, either through increased native plant gardens or meadow areas, low-mow areas, or shifting to electric equipment will not only aid in improving air quality, but also reduce noise and water pollution, and increase habitat and soil health. Additionally, conversion of turf grass to native plants through reduced mowing provides the co-benefits of increased carbon sequestration in the soil and reduced stormwater runoff.

Overcoming Barriers

Electric landscaping equipment has a high startup cost so determining the return on investment (ROI) will be important. Education, outreach, and demonstration areas can help overcome any community concerns associated with transitioning from traditional landscaping to sustainable landscaping practices.

Tracking Progress

As we implement this strategy, we will track acres of turf converted to low-mow or native plantings, amount of gas-powered equipment converted to electric, as well as all associated GHG emissions reductions.

Implementation

The Department of Recreation and Parks (DRP) will be the lead implementer in collaboration with the Office of Community Sustainability (OCS), Department of Public Works -Highpage 81ways (DPW), and the Howard County Public School System (HCPSS).

Next Steps	Timeline	Responsibility
Identify parks and other public open space that could be converted to low- and no-mow areas. Consider incorporating compost as a soil amendment (suburban subsoiling) in these areas to increase infiltration through decompaction and encourage deep-rooted plant growth for carbon sequestration and soil retention. Plan for management of invasives in these areas. Hire new staff and increase funding where necessary.	2023-2024	DRP, OCS
Establish a County-wide outreach campaign to raise awareness, acceptance, and appreciation for the value of soil health, native plants, reduced mow areas, and meadows. Consider partnering with Howard County Bee City on these efforts.	2023-2025	OCS, DRP, HCPSS
Coordinate with HCPSS to expand existing no-mow efforts and incorporate compost soil amendments (suburban subsoiling) and deep-rooted plants requiring minimal mowing into field spaces or little used turf areas.	2024	HCPSS, OCS

Continue to reduce chemical fertilizer and pesticide applications on County property, while also educating private property owners about the benefits of sustainable landscape maintenance.	2023-2025	DRP, OCS, DPW Highways, HCPSS
Pilot an electric landscaping equipment conversion program to begin phasing out gas-powered equipment where possible.	2023-2024	OCS, DRP
Continue to seek innovative nature-based climate solution methods and opportunities to lead by example in improving soil health and GHG emission reductions on County land.	Ongoing	OCS, HCPSS
Determine baseline GHG emissions from mowing County land and set reduction goals.	2023-2025	DRP, OCS, DPW Highways, HCPSS

Strategy N2: Conserve Existing Forests and Expand the Tree Canopy

Healthy forests hold significant potential for carbon sequestration. Trees outside of forests sequester carbon as well, but less so than those within forests. Planting and maintaining native tree species also preserves biodiversity and improves climate resiliency. This strategy builds on the County's ongoing work to increase tree cover and sequester carbon by identifying priority areas for forest conservation and new tree planting.

Why These Actions?

Forests and their soils, as well as trees outside of forests, are Howard County's most obvious carbon stocks. As we strive to reach net zero emissions, increasing or at least maintaining the carbon stocks in our forest and canopy resources will be essential for offsetting emission sources difficult to eliminate entirely. Most trees in Howard County's largest forests are of a prime age for sequestering carbon and will be for decades to come. Still, as old trees die naturally or succumb to vines, insects, clearing, or changes in climate, new forests will need to take their place to maintain Howard County's carbon stocks and sequestration potential. To that end, existing forests will need to be managed to ensure regeneration, and new forest will need to be planned and protected into the future.

Addressing Equity

Tree canopy is especially critical in areas where populations are most vulnerable to heat waves and high temperatures, which tend to include people with lower incomes, people of color, people with disabilities and people who are 65 and older. Tree planting in underserved areas provides co-benefits such as reducing heat island impacts, storing carbon, and providing habitat for wildlife.

Howard County Leading by Example

Howard County has already begun work on preserving and growing forest and tree canopy. The updated Forest Conservation Act increased replanting requirements for tree clearing, strengthened protections for "champion" and "specimen" trees, and increased the required maintenance period for Forest Conservation Easements. Howard County manages and promotes a variety of tree planting initiatives and protects existing forests through deer management and invasive species management where possible.

GHG Impacts

Forests and urban trees sequester carbon from the atmosphere, while the conversion of forests to other land uses results in a net carbon release. Initial investigations begun by the Office of Community Sustainability in 2022 suggest that the County's forested lands and tree canopy offset roughly 7% of all County emissions in 2019, at an estimated net 252,960 MTCO2e (metric tons of carbon dioxide equivalent) removed from the atmosphere per year. This number was generated using the International Council for Local Environmental Initiatives' Land Emissions and Removals Navigator, or "LEARN

Tool," an online application designed to help local governments quantify the carbon stocks of their forests and trees outside of forests. Changes from forest to other land use, and other canopy loss emitted an estimated 26,263 MTCO2e, which was accounted for and subtracted from a larger carbon sequestration estimate, to provide the net 252,960 MTCO2e figure. While the estimate provided with this tool notes that the MTCO2e values may be up to 45% greater or less in reality than indicated through the model, the model can reliably indicate the directionality of sequestration over time; that is, whether the forested and treed parts of the landscape are increasing or decreasing their carbon stocks and sequestration ability.

Action 1: Protect and restore forest and non-forest tree canopy

This action seeks to protect and conserve existing forests and trees, restore degraded forests, and increase the planting of native trees throughout the County on public and private lands. This will increase carbon sequestration and offer many resiliency co-benefits.

Overcoming Barriers

The County government owns a small portion of Howard County land and therefore significant planting on private property will need to occur to achieve and maintain forest and tree canopy goals, as well as GHG emissions reduction goals. The County will need to attract more willing landowners to preserve and plant forest acreage. Additional staff, equipment, and funding is needed to maintain current forest and canopy resources, and funding for long term management needs to be in place when planning new planting projects. Invasive species, particularly vines, pose a threat to maintaining tree canopy, and the overpopulation of white-tailed deer has minimized natural forest regeneration across the County.

Tracking Progress

Metric	Baseline	Goal
MTCO2e removed by forests and trees outside of forests	252,960 (7% of 2019 combined emissions from all sectors offset)	275,000 (7.3% offset of 2019 emissions) 300,000 (8% offset of 2019 emissions) (2045)
Achieve and sustain 50% tree canopy.	49.1 % (2018)	49.5% (2030) 50% (2045)

Implementation

The Department of Recreation and Parks will be the lead implementer for this action, with support from the Office of Community Sustainability, the Department of Planning and Zoning, and the Department of Public Works.

Next Steps	Timeline	Responsibility
Expand tree planting efforts across land uses, both public and private.	Ongoing	DRP, OCS
Evaluate the effects of recent updates to the County and State Forest Conservation Acts and consider updates to the County Forest Conservation Act and Forest Conservation Manual to address any gaps in tree protection during the development process.	2023-2030	DPZ, DRP, OCS
Expand existing invasive species management programs with a focus on forest canopy preservation. Plan for maintenance and long-term management in budgets and with each tree planting in the future.	2023	DRP, OCS

Evaluate new methods of reducing the deer population to allow for forest regeneration.	2024	DRP, OCS
Account for CO2 sequestration in County forests and tree canopy, as well as emissions from forest and canopy losses. Update the inventory as new land cover maps and CO2 accounting tools are made available.	Ongoing	OCS

Resiliency Strategies

Strategy R1: Become a model for excellent communication, education, and outreach about climate hazards, emergency preparedness, and available resources

Risks and impacts of climate hazards can be reduced if the public is well informed of resources and best practices in managing risks and impacts. Howard County already facilitates conversations and disseminates information on emergency preparedness via departments working within emergency management, public health, and citizen services departments. Going forward, Howard County will take communication, outreach, and education to the next level, ensuring highly accessible and relevant information is disseminated in the most effective means possible, and that all residents, businesses, and County employees are aware of how to prepare, what resources are available to them and where to go for more information. Howard County will provide a cohesive and prioritized suite of communication, education, and outreach resources to the public to become a model in the climate resilience communications space.

Why These Actions?

These actions were chosen to increase communication around climate preparedness, emergency management, and other related information. While there is a lot of information available to residents, Howard County can work more on making sure that this information reaches everyone in an effective and equitable way. The following actions will increase the effectiveness of distributing information and making sure the information is available in many formats. Howard County will work on consolidating climate information for residents. Additionally, Howard County will improve outreach and communications to the County's diverse community. The 2022 Climate Change Emergency Preparedness Survey informed these actions.

Addressing Equity

Increasing and improving communication, outreach, and education to all Howard County residents will ensure that underserved communities have access to critical emergency preparedness information. Incorporating new outreach techniques and tools will help the County reach underserved communities with this information.

Howard County Leading by Example

Howard County has one of the highest COVID-19 vaccination rates in the country. Its Health Department's robust outreach plan reached underserved populations through mobile vaccine clinics and COVID-19 testing sites. Department of Fire and Rescue Services, Mobile Integrated Community Health team, Howard County Health Department, and other departments who assisted in this effort made vaccines and testing accessible for seniors, individuals with Disabilities/Access and Functional Needs (D/AFN), and those who may not have the access or resources to get vaccinated/tested at traditional sites. Many lessons were learned about reaching new populations and this knowledge can be used to enhance climate resiliency outreach efforts.

Action 1A: Create a one stop shop for all resources and services relating to climate hazards

Consolidate all relevant emergency management, public health, and state and local resources related to preparing for and dealing with climate-related and non-climate related emergencies to one single online portal and physical document. Simplify the most important information for the front pages of the online portal and add links that redirect residents to Howard County resources. Explore options in communicating information through an easy-to-remember phone number such as the 211 Maryland United Way Helpline. Increasing public and employee awareness of resources and services and where to go to find this information and ensuring information is easily accessible.

Overcoming Barriers

This action was chosen because information regarding how to prepare for and deal with climate hazards are distributed in multiple online webpages, making it difficult for users to find relevant information quickly and efficiently. Creating one place for all relevant state and local resources can decrease the amount of time spent looking for this information and makes it more likely the information will be available when needed.

Implementation

The Office of Emergency Management (OEM) and Office of Community Sustainability (OCS) will be the lead implementers for this action, with support from The Office of Public Information (PIO) and Department of Technology and Communication Services (DTCS).

Next Steps	Timeframe	Responsibility
Collaborate with relevant departments to collect all information regarding climate hazards, other non-climate emergencies, and climate action.	2024-ongoing	OEM, OCS
Create an organized webpage and document to store relevant information. This webpage should contain relevant information in multiple languages, and it should be made accessible for individuals with disabilities.	2024-ongoing	OEM, OCS, DTCS, PIO
Create summary page with the most critical information using information provided by OEM and OCS. Other pages can include events, weather tracking, plans, and resources on preparation and resiliency.	2024-ongoing	OEM, OCS, DTCS, PIO
Explore whether this information can be incorporated into an existing number like 211. Create an easy-to-remember and easy-to-use local phone number for residents to call to get the most critical information.	2024-ongoing	OEM, DTCS, PIO
Provide public-facing employees with informational guides on how to help residents find critical information. Train all public-facing employees on how to access the webpage, summary page, and phone number.	2023-ongoing	All applicable departments in Howard County
Conduct a user-study to determine if “one-stop-shop” webpage and phone number is easy to use and findable and improve as needed.	2024-2025	DCRS, PIO, DTCS
Develop promotional material, taglines or graphics for all County communications and websites, etc. to help get the word out about it, outreach to news organizations to get their help getting the word out, etc.	2023-ongoing	PIO, OEM
Continue to collaborate with departments and update webpage with relevant information.	Ongoing	OEM, OCS, PIO, DTCS, All applicable Howard County departments

Action 1B: Improve existing communication, education, and outreach methods and research best practices to reach communities.

Howard County departments that interface with the public use a variety of communication, education, and outreach methods. Internal stakeholders should collaborate with other departments to identify and bolster methods that are successful and identify methods that can be improved. Stakeholders should incorporate new or improved communication, education, and outreach practices into messaging specific to emergency preparedness, climate resiliency, and other climate-related information. Additionally, the County should work with non-profits, community

organizations, and other partners to build trustworthy relationships with different communities where additional or unique outreach approaches need to be considered.

Overcoming Barriers

Despite Howard County already having communication, education, and outreach methods used to reach the public, the 2022 Climate Change Emergency Preparedness Survey shows that there are some gaps in communication regarding how well the community feels they are prepared for disasters and where they can find information related to emergency preparedness. Additionally, results show that many Howard County residents are not aware of disaster/emergency preparedness resources and services that may be available to them following a disaster. It is important that the County can effectively disseminate information through communication and outreach methods regarding emergency preparedness and climate resiliency in the community to help residents know more about climate hazards, emergency preparedness, and available resources and services.

Tracking Progress

Metric	Baseline (2022)	Goal (2024)
Percentage of people who know where to find emergency preparedness resources (Based off the 2022 Climate Change Emergency Preparedness Survey).	54.8%	80%
Percentage of people who feel prepared if an emergency event were to occur (Based off the 2022 Climate Change Emergency Preparedness Survey).	37.2%	60%

Implementation

Department of Community Resources and Services (DCRS), Office of Human Rights Equity (OHRE), and Office of Emergency Management (OEM) will be the lead implementers of this action, with the support from the Office of Public Information (PIO), the Office of Community Sustainability (OCS), and all applicable departments.

Next Steps	Timeframe	Responsibility
Conduct an audit of existing methods of communication, education, and outreach to identify gaps.	2023-2024	DCRS, OHRE, OEM
Conduct a user study to determine the best methods of communication and distributing information through education and outreach.	2023-2024	OHRE, PIO, DCRS
Research new methods of communication, education, and outreach to ensure modes of communication are equitable.	2023-2024	DCRS, OHRE, PIO
Take research, results from user study, and feedback from departments to implement new strategies, build upon and/or improve existing strategies. Those who do a lot of outreach and education with the community should follow new strategies, especially with information regarding emergency preparedness and climate resiliency.	2024-2025	OEM, OCS, OHRE, DCRS
Publish a resource guide with best methods to communicate, educate, and conduct outreach for other departments and communities to follow.	2024-2025	OHRE, DCRS

Subject Matter Experts on emergency preparedness, recovery, and resiliency should reach out to external partners and educate them on climate information, available resources and services, and the best ways to educate and communicate with their own members.	2024-ongoing	OEM, OCS, All Applicable Departments
Work with internal and external partners, with a focus on nontraditional partners, to distribute emergency preparedness, climate-specific, and resiliency information as widely as possible.	Ongoing	All applicable departments
Create and distribute a 2024 Climate Change Emergency Preparedness survey that contains similar questions to the 2022 Climate Change Emergency Preparedness survey. Survey residents to see if communication and outreach of County resources has improved. The survey should be expanded and include questions about climate resiliency to see if residents know about energy efficiency, stormwater practices, agriculture, land**,** and other programs.	2024-2025	OCS, OEM

Action 1C: Ensure equitable access to information.

Emergency preparedness information should be accessible for those who may struggle to gain information through traditional communication modes (i.e., social media, internet-based news, television, etc.). The information the County publishes should be easy to understand and made available in languages other than English and in alternate formats that are more accessible to individuals with Disabilities/Access and Functional Needs (D/AFN). The County should evaluate its current structure/modes for disseminating information to include the inclusiveness, accessibility, and effectiveness of existing channels to access information. Based on that evaluation, the County should then determine the best methods of distributing equitable accurate information and determine any communication gaps. The County should consider incorporating a phone number for residents to call to be able to access the information in alternate formats.

Overcoming Barriers

This action is chosen because being able to access information quickly post-emergency is vital to community resiliency. Although the County does provide information to the public that can be accessed equitably for individuals with Disabilities/Access and Functional Needs (D/AFN), there is still a lot of information that cannot be accessed in an accessible way. Residents should feel confident that they are able to access information in alternate formats and different languages to fit their needs.

Implementation

Department of Community Resources and Services (DCRS) and Office of Human Rights and Equity (OHRE) will be the lead implementers for this action, with support from the Office of Emergency Management (OEM) and the Office of Public Information (PIO).

Next Steps	**Timeframe**	**Responsibility**
Conduct a user study to determine accessibility of current information. This user study can be combined with determining the best methods of communicating and distributing information through education and outreach.	2023-2024	OHRE, DCRS
Meet with departments and Subject Matter Experts (SMEs) who incorporate accessibility into their messaging and discuss the best ways to distribute information regarding climate resiliency	2023-2024	OHRE, DCRS, PIO, OEM

Incorporate accessibility into all relevant outreach methods and communication modes, especially any media or websites that contain climate resiliency, preparedness information, and the “one-stop-shop" website/landing page.	2024-ongoing	All applicable departments
Develop a list of nontraditional communications channels and update no less than annually. Make sure all departments communicating about emergencies and emergency preparedness have access to this list and are using it.	ongoing	OHRE, PIO

Action 1D: Maximize outreach opportunities by layering emergency preparedness information into County communication tools.

Outreach opportunities should be utilized to their fullest potential to make sure people are aware and know how to access available emergency resources and services, emergency preparedness information, and climate-specific preparedness information. Howard County should continue to take advantage of any opportunity to disseminate this information through press releases, newsletters, social media pages, County employee signatures, and other potential opportunities. This action encourages other County departments, including departments with a lot of interaction with the public and a lot of opportunities for public outreach, to push out emergency preparedness information and become informed on emergency preparedness. Additionally, this action should encourage departments to improve internal communication with each other to increase the County’s awareness of emergency preparedness to better assist residents. The County should continue to collaborate with partner organizations, including schools, businesses, and nonprofits to share information regularly with their members and explore paid media.

Overcoming Barriers

At times, communication can be misunderstood and/or need improvements. This action is chosen because maximizing outreach opportunities into all County communications can help increase the number of people who are prepared for climate emergencies by increasing awareness of available resources and services. Information can be most effectively disseminated when using the greatest variety of channels of communication.

Implementation

Office of Public Information (PIO), Public Information Officers (PIO’s) and Office of Emergency Management (OEM) will be the lead implementers for this action, with support from the Department of Community Resources and Services (DCRS) and from all applicable departments who have a lot of interaction with the public.

Next Steps	**Timeframe**	**Responsibility**
Develop standardized templates for County departments to use on their social media posts/sites, employee signatures, newsletters, and other communications to direct the public toward the best sources of emergency preparedness information.	2023-ongoing	PIO, All applicable departmental PIOs, OEM
Expand list of internal County contacts and external partner contacts that can be used to easily disseminate information broadly. Update regularly.	Ongoing	OEM, All applicable departments
Ensure County departments are communicating and distributing the necessary information to their external partners so that they can push out information with their members when appropriate	2024-ongoing	OEM, PIO, DCRS, All applicable departments

Strategy R2: Improve emergency preparedness of Howard County citizens

Making sure that the public is prepared and well-equipped to deal with a variety of climate hazards can help reduce the impacts of those climate hazards. Howard County's Office of Emergency Management, the Department of Community Resource Services, and the Howard County Health Department already have emergency resources and services that can help people prepare for extreme temperature, flooding, and other emergency/disaster events. However, the County can increase the amount of people who know how to respond to climate disasters, what emergency supplies to have, and where to access emergency resources and services.

Why These Actions?

Emergency preparedness can help people know what to expect during extreme temperature events, extended power-outages, and other climate risks and impacts. Providing the public with the information and resources most needed following a climate emergency is critical. These actions help increase the number of Howard County residents who are prepared for climate emergencies, through outreach and ensuring organizations have adequate resources. Having specific materials and resources readily available will help Howard County's population recover effectively and swiftly from climate hazard impacts. The County is aware there are many factors to consider when increasing education and outreach efforts for emergency preparedness. The County will conduct targeted outreach to individuals residing in the County who may be more vulnerable to extreme heat, flooding, and other hazards because of their geographical location, socioeconomic situation, and other factors. This action was chosen because Howard County wants to ensure that residents are more resilient, specifically for extreme temperature events. Overall, this strategy will increase emergency preparedness of residents.

Addressing Equity

This strategy ensures that underserved communities are prepared for emergency events by ensuring equitable distribution of and providing affordable emergency preparedness and climate action resources and services across the County.

Howard County Leading by Example

There are several plans published by the Office of Emergency Management that address climate hazards and how the County responds to disasters, such as Howard County Hazard Identification Risk Assessment (HIRA) Plan, Howard County Hazard Mitigation Plan, The 2020-2025 Office of Emergency Management Strategic Plan, Howard County Comprehensive Emergency Response and Recovery Plan (CERRP), and an Animal Disaster Preparedness Packet. Additionally, they provide digestible resource packets such as the Community Hazard Handbook. The Office of Community Sustainability has many resources about climate actions that residents can partake in to be more resilient to hazards in their own home and backyard such as stormwater and energy related solutions. To help residents find available resources and services near them, Howard County has partnered with the CAREAPP service that connects Howard County residents with resources and services that assist with or provide transportation, housing, food, education, and more. The County developed two different centers, the Family Assistance Center (FAC) and Disaster Assistance Center (DAC), that are activated after an emergency to provide people with emergency support resources such as case management support for food, water, and shelter. These centers may provide similar services but are activated depending on the type of recovery services are needed.

Action 2A: Increase number of individual citizens with emergency kits and emergency plans.

Emergency kits contain supplies that will last for several days following an emergency, including food, water, and other resources that fit an individual's or families' specific needs. The Office of Emergency Management and the Howard County Health Department distribute and encourage individuals (via outreach events, social media posts, etc.) to build

emergency kit(s). Increasing the number of individuals with emergency supply kits or information on what goes in an emergency supply kit can help increase community preparedness and resiliency.

Overcoming Barriers

This action is chosen because emergency kits are a necessity following a disaster incident(s). People can use emergency kits to address acute and immediate needs instead of relying on outside resources and/or services. The 2022 Climate Change Emergency Preparedness survey results highlight that many individuals do not have emergency supplies.

Implementation

Office of Emergency Management (OEM) and the Office of Community Sustainability (OCS) will be the lead implementer for this action, with support from the Department of Community Resources Services (DCRS) and all applicable departments/organizations.

Next Steps	Timeframe	Responsibility
Use communication and outreach methods developed under Strategy R1 to increase public awareness about the importance of emergency supply kits and how to put together a kit.	Ongoing	OEM, OCS
Promote the usage of emergency plans and kits at tabling events across the County, giveaway information on what goes in an emergency kit and the usage of emergency plans, kits, etc. right before an extreme weather event like a hurricane or extreme temperature events.	Ongoing	OEM, OCS
Consider holding a contest for the most creative and effective emergency kit to raise awareness.	2024-ongoing	OEM
Find sources of funding to provide departments and partners with basic emergency kit supplies or giveaway items. Consider partnering with Community Action Council (CAC) of Howard County and other organizations to provide emergency kits to those with qualifying incomes in communities most vulnerable to flooding, heat, or other impacts of storms.	2024-ongoing	OEM, DCRS, all applicable departments/organizations

Action 2B: Increase capacity of organizations that can provide emergency services before and during an emergency.

Howard County is fortunate to have several organizations that provide needed supplies and services before and during emergency events. Increasing support and resources available to these partner organizations can help reduce supply shortages, reduce over-crowding of shelters and supply distribution locations, and distribute more resources across the County. This action helps ensure that organizations who already provide food, water, shelter, and other resources have adequate supplies to give out during an emergency by helping them secure additional funding for resources and services. Howard County also can further promote these partners and raise community awareness of available services by including these organizations and their services on the “one-stop-shop" webpage.

Overcoming Barriers

This action is chosen because more emergencies are expected to occur, and the number of resources and services will have to increase. More resources should be made available to residents. Well-prepared and amply resourced nongovernmental service organizations can help with this effort.

Implementation

Department of Community Resources and Services (DCRS) will be the lead implementers of this action, with support from the Office of Emergency Management (OEM).

Next Steps	Timeframe	Responsibility
Ensure CAREAPP, “One-Stop-Shop", and other sources that share information on resources and services provided by organizations and departments are up to date. Determine if there are gaps or missing existing community services and resources.	2023-ongoing	DCRS, OEM
Increase the number of residents who are aware of the CAREAPP and existing resources and services. Assist organizations in promoting their resources and services, especially during and after an emergency event.	2023-ongoing	DCRS, OEM
Reach out to existing organizations to determine if additional funding for resources and services is needed to fill in gaps.	2024-ongoing	DCRS
Seek funding to assist organizations in providing more robust emergency services to Howard County residents.	2024-ongoing	DCRS, OEM

Action 2C: Target more education and outreach efforts about emergency preparedness and climate action to communities most vulnerable to heat and flooding impacts.

Targeted education and outreach efforts to increase emergency preparedness should be directed toward individuals living in parts of the County that are expected to be most impacted by extreme temperature and flooding, as well as individuals with higher health risks when exposed to these conditions. The Department of Public Works has disseminated information on flooding hazards to residents living in areas susceptible to flooding, however, these efforts could be expanded. For example, extreme temperature preparedness outreach and education efforts can target those living in urban areas and populations that are more susceptible to extreme temperature exposure (i.e., individuals with Disabilities/Access and Functional Needs (D/AFN). The Howard County Office of Emergency Management already provides County residents with emergency preparedness and public health related information, however, expanding on the County’s reach to the public and promoting more climate specific emergency preparedness would be beneficial. County stakeholders could help expand education and outreach efforts. Education and outreach relating to emergency preparedness for extreme temperature events and extreme weather impacts should continue to be expanded to underserved communities. Relevant partners should continue educating the public on climate and general emergency preparedness ahead of a disaster through workshops, videos, social media, newsletters, mail, and other methods of effective outreach identified in Strategy R1.

Overcoming Barriers

The County is aware there are many factors to consider when increasing education and outreach efforts for emergency preparedness. Individuals residing in the County may be more vulnerable to extreme heat, flooding, and other hazards because of their geographical location, socioeconomic situation, and other factors. This action was chosen because Howard County wants to ensure that residents are more resilient, specifically for extreme temperature events.

Implementation

Office of Emergency Management (OEM), Department of Community Resources and Services (DCRS), and Office of Community Sustainability (OCS) are the lead implementers for this action, with support from Economic Development Authority (EDA), Office of Human Rights and Equity (OHRE), the Office of Public Information (PIO), Department of Public Works - Bureau of Environmental Services (BES) and all applicable departments.

Next Steps	Timeframe	Responsibility
Determine where and what kind of targeted outreach is needed using heat and flood, equity maps and other tools. This action should be updated every year as climate hazards are expected to increase and residents may be more susceptible to the impacts of climate hazards.	2023-ongoing	OEM, OCS, DCRS, PIO, OHRE
Work with OEM and other relevant departments to improve the preparedness of Howard County residents and/or business owners for specific hazards relevant to their area.	2023-ongoing	OEM, OCS, EDA, DCRS, OCS
Implement improved or new education and outreach efforts targeting relevant areas, communities, etc.	2024-ongoing	DCRS, OEM, BES, PIO, all applicable departments
Assess if education and outreach has improved Howard County's preparedness levels and get feedback on targeted education and outreach efforts and adjust as needed.	2024-ongoing	OEM, DCRS

Strategy R3: Improve access to emergency shelters, cooling centers, and resources during climate hazard events, especially for underserved and under-resourced communities

This strategy will explore options to improve access to emergency shelters, warming/cooling centers, and other resiliency and recovery resources. The County should explore additional opportunities to add more emergency shelters and warming/cooling centers throughout the County in feasible locations. Additionally, the County may need to increase transportation options to get people to and from emergency shelters and warming/cooling centers.

Why These Actions?

Ensuring that adequate access to transportation and to County resources and services is secured ahead of climate hazard events, such as extreme heat/cold events, will ease operations of the County's emergency response and public health processes.

Addressing Equity

Howard County will ensure that community members with specific mobility needs have access to affordable and accessible public transportation options by improving Americans with Disabilities Act (ADA) compliance. Additionally, the County will offer no- cost and low-cost transportation options. This will ensure that equitable preparation and recovery efforts are offered before, during, and after climate hazard events.

Howard County Leading by Example

Howard County has pre-established sheltering and amenity capabilities for disaster and non-disaster incidents. These resources can provide the public with warming/cooling centers during extreme weather events, amenity centers for charging electrical devices during power outages, and overnight sheltering following an emergency/disaster incident. These different types of resources are activated upon specific triggers, such as the type and severity of the weather, or as needed by the community. Howard County's mobility services include General Paratransit (GPT) which offers free rides on fixed routes and trips to senior centers, medical appointments, social service agencies, employment, and education, and select hospitals. Regional Transit Agency's (RTA) Complementary ADA Paratransit complements RTA services a large area of 128 square miles and provides services to certified ADA persons, including free rides on fixed routes.

Action 3A: Raise awareness of and add new warming/cooling centers, emergency shelters, and comfort centers as needed, prioritizing underserved areas

Extreme weather events, such as flooding, extreme heat, and winter storms may require the County to establish more cooling/warming centers in existing buildings. It is important that residents know what options are available to fit their needs. Additionally, it's important that residents know the differences between warming and cooling centers and emergency over-night shelters as they each provide different services and functions. The County should work with housing complexes, schools, and community organizations to identify areas where additional warming/cooling centers are feasible and useful to the public, especially for those who lack viable transportation options to the nearest center. Consider adding warming/cooling centers in places where vulnerable populations are more impacted by extreme temperature events and in more accessible and equitable locations (i.e., near bus stations, within walking distance of residential areas, etc.).

Overcoming Barriers

This action is chosen because new warming/cooling centers may need to be considered to help areas with a high-volume of underserved residents and/or residents who are in areas that are vulnerable to extreme temperature events and flooding. Currently, Howard County has 15 locations established as warming/cooling centers for extreme weather events and those centers are not utilized to their full potential. However, the County's 2022 Climate Emergency Preparedness Survey indicated that a large sector of the public would use warming and cooling centers if they knew it was an option. We can expect the use of these services to increase as the County improves education and awareness of these services. In addition, survey respondents indicated that lack of transportation is one of the largest barriers preventing their use of existing heating and cooling centers. Increasing the number of centers in places where people can easily access them by walking or public transit improves accessibility.

Implementation

Office of Emergency Management (OEM), Office of Community Sustainability (OCS), and the Department of Public Works (DPW) will be the lead implementers of this action, with support from Howard County Public School System (HCPSS), Department of Technology and Community Services (DTCS), Office of Public Information (PIO), Department of Community Resources and Services (DCRS), and all applicable departments.

Next Steps	Timeframe	Responsibility
Use extreme temperature vulnerability maps, flood vulnerability maps, and demographic data (such as EJ Screen), to identify priority geographic areas where new centers are most needed.	2023-ongoing	OEM, DCRS
Review the list of critical facilities within Howard County to identify existing facilities within these priority areas that could serve as new warming and cooling centers. Meet with stakeholders and community groups to further refine the list of existing facilities to assess for suitability as warming and cooling centers.	2024-2025	OEM, DPW- Facilities, OCS, DCRS, All applicable departments
Utilizing existing criteria, implement new centers as needed and feasible.	2024-2026	OEM, DPW-Facilities, HCPSS
Map new centers and include center locations in the "one-stop-shop" webpage.	2024-ongoing	OEM, OCS, DTCS, PIO
Conduct targeted outreach in neighborhoods within walking distance of new and existing warming and cooling centers to raise awareness of shelter availability and locations.	Ongoing	OEM, OCS

Survey target populations to determine whether new placements of warming/cooling centers are accessible and adjust locations as needed.	Ongoing	OEM, DCRS, OCS

Action 3B: Maximize transportation options to get to and from emergency centers during climate hazard emergencies

During extreme weather events, people need to be able to access various transportation modes and options to get to safety. An ADA-compliant transportation plan during large and localized climate emergency events should be developed. Affordable transportation options focused on getting people to and from emergency centers should be considered a priority during extreme weather events.

Overcoming Barriers

Affordable and accessible transportation for residents is crucial especially during emergency situations. Initial research of the 2022 Climate Change Emergency Preparedness survey shows that lack of transportation is a barrier residents face when accessing community resources and services.

Implementation

The Office of Transportation (OOT), Department of Community Resources and Services (DCRS), and Office of Community Sustainability (OCS) are the lead implementers for this action, with support from Howard County Public School System (HCPSS) and Department of Recreation and Parks (DRP).

Next Steps	**Timeframe**	**Responsibility**
Identify emergency events that could trigger acute transit needs for individuals with D/AFN, lack of access to personal vehicles, or other reasons.	2024-2025	OEM, DCRS
Identify and prioritize neighborhoods with greatest need for emergency transportation to shelter and recovery resource locations based on demographic information and vulnerabilities to flooding, extreme temperature events, and other climate hazards.	2024-2025	DCRS, OCS
Identify stakeholders and community groups that can provide new resources to address transit needs.	2024-2025	DCRS, OOT
Explore options for diverting public transit buses, rideshare services, school buses, and vans to serve emergency needs.	2024-2025	OOT, HCPSS
Generate a list of new resources that fill gaps in transit needs during climate hazard events.	2024-2025	OOT
Incorporate new local funding initiatives to support these new transit resources.	2024-ongoing	OCS, OOT
Conduct education and outreach campaigns in targeted neighborhoods to raise awareness of the availability of new emergency transit options.	2024-ongoing	OCS, OEM, DCRS, DRP
Survey target populations to determine whether new emergency transit services meet communities needs and adjust program as needed.	2025-ongoing	DCRS, OCS, OEM, OOT

Strategy R4: Increase resiliency of buildings, infrastructure, and communities to match anticipated climate hazards

Commercial and residential buildings, roads, bridges, and other built infrastructure may be ill-equipped to withstand the stress of more intense heat waves, extreme storms, flooding, and other anticipated climate hazards. Building codes, design standards, and best practices that improve resiliency of these structures can include energy efficiency practices, climate-resilient construction materials, weatherization techniques, flood resistance measures, a highly trained workforce to repair critical equipment in emergencies, and on-site energy generation (including solar and battery storage) to better withstand extreme weather, flooding, and extended power outages. Promoting climate resilient building codes, infrastructure design manuals, and best practices that are co-beneficial with energy efficiency initiatives and climate resilience can foster effective improvements to buildings, roads, bridges, and other built infrastructure throughout Howard County.

Why These Actions?

Howard County needs to prepare for the increase in severe storms, intense heat, and increased flooding expected because of climate change. Most the County's existing buildings and other infrastructure were not designed to withstand these increases in extreme weather. Proactive decision-making to harden critical facilities and shelters will prepare these locations to withstand climate hazard impacts and can prevent the worst impacts of climate hazards from occurring.

Intense heatwaves and related prolonged power outages are likely to become more frequent due to climate-related extreme weather and associated increased demand on the electric utility grid. At the same time, climate change hazards such as heat waves and flooding make uninterrupted access to public safety and community resources even more critical. Power outages and extreme temperatures also put increased demand on highly skilled technicians who can install, repair, and maintain HVAC systems, generators, and microgrids.

Howard County, as a recognized leader in the development and adoption of modern international building codes, is in a unique position to pilot and advocate for code improvements targeted toward specific needs for building stock resiliency and public safety concerns resulting from climate hazards.

Addressing Equity

Extreme heat due to climate change is expected to be worse in some areas than others due to urban heat island effects. In addition, extreme heat can disproportionately impact highly sensitive groups such as people with breathing issues and the elderly. People with lower incomes also can suffer more from extreme heat because they often occupy older buildings and may not have adequate cooling systems or options for backup power in case of outages. There are many best practices that can reduce heat island effects and protect heat-sensitive groups from extreme heat. Retrofits of existing buildings and other infrastructure to reduce energy demand and improve resiliency to heat and flooding should prioritize buildings, roads, bridges, and other infrastructure critical to public health and safety and that provide services to under-resourced communities. Increasing the ability of Howard County's community centers to provide services and resources during emergencies also benefits surrounding underserved communities.

Howard County Leading by Example

Howard County has already demonstrated leadership in many of the areas critical to successfully implement this strategy. Howard County's Department of Inspections, Licenses and Permits staff are active participants in several International Code Council committees and workgroups that continuously revise and update codes to best protect people and property, as well as saving energy and reducing life cycle building costs. Howard County has the highest Insurance Services Office (ISO) Rating in the state of Maryland for Commercial and Residential. This rating is based on the ratio of inspectors to buildings, enforcement of existing codes, and certifications and expertise of inspectors. Howard County also has led the state with climate-forward code. For example, Howard County first required electric vehicle charging stations for new multi-family dwelling units in 2019, which is now included in the 2021 International Energy Conservation Code. As of 2022, Howard County has adopted all the most recent versions of international building codes, except for the

International Green Construction Code overlay. The adoption of modern building codes is rare among local jurisdictions in the United States, prompting a new federal effort to increase adoption of modern building codes, called the National Initiative to Advance Building Codes.

In addition, Maryland was the first state in the nation to require that nursing homes and assisted living facilities provide emergency backup power. Maryland Code 10.07.14.46 requires that assisted living facilities serving more than 50 people have an emergency electrical power generator on the premises and that certain areas specified in the rule and law are covered. System tests are required once per month and the generators must be at full speed within 10 seconds of activation.

Action 4A: Continue to lead nationally on building safety and resiliency by researching and piloting building code updates to increase resiliency to severe storms, flooding and heat beyond life safety

Strong, modern building codes help keep people safe and reduce damage to buildings from extreme storms, heat waves and other climate hazards. While building codes have begun to address energy efficiency and other climate change mitigation measures in the last decade, building codes traditionally focus on life safety, ensuring buildings operate long enough to safely evacuate people in a disaster, rather than ensuring people can continue to safely live in those buildings during and after emergency events. Targeted building code updates can improve long term building resiliency in a changing climate. For example, higher standards for storm resistant siding, windows, and doorways in buildings can prevent damage during storms. Building codes related to the location of internal systems and utilities can also improve the overall resilience by shifting sensitive assets away from potential flooding or overheating due to extreme weather. Code and other policy also can protect against building flooding and resulting mold hazards. Targeted code updates also can help reduce heat islands by using reflective building materials and including more shade plantings and other heat mitigation measures on site.

Overcoming Barriers

Successful adoption of new building codes requires education of contractors and developers to ensure they fully understand and can implement the new code. In addition, code compliance relies on adequate code enforcement, so Howard County needs to make sure it has the required staff and resources available before code changes are adopted.

Implementation

The Department of Inspections, Licenses, and Permits (DILP) will be the lead implementor for this action, with support from the Office of Community Sustainability (OCS).

Next Steps	Timeframe	Responsibility
Continue to participate actively in International Code Council committees and in state and regional code working as they evaluate additional resiliency measures in code updates.	Ongoing, quarterly	DILP

Investigate the latest research and innovations in building codes to promote climate resiliency and evaluate these for inclusion in Howard County code. Focus on research and innovations that directly address Howard County's priority climate hazards: flooding, heat, and severe storms as well as resulting power outages. Consider adopting a climate-ready building standard. For example, revise codes to achieve more floodproofing, location of mechanical and electrical equipment above projected flood elevations, etc.	2024 (updated every three years through the code adoption cycle)	DILP
Investigate options to protect tenants from health impacts of climate hazards and update regulations as needed. For example, this could include requiring landlords to install measures to protect against flooding in their properties, especially in basements, and to inspect for mold and remediate as needed within a specified timeframe after flooding events to protect occupant health.	2024 (updated every three years through the code adoption cycle)	DILP
Synthesize the findings of the above research and suggest ways to incorporate these findings into building codes and best practices, including details about any additional staff, budget, partnerships, or other resources needed to implement any recommended code updates effectively.	2024 (updated every three years through the code adoption cycle)	DILP
Actively pursue adoption of the International Green Construction Code and funding for the additional DILP staff needed to implement and enforce the code effectively. Consider including requirements that non-critical facilities install measures to reduce energy use during extreme weather events to conserve available electricity supply for critical services such as ventilators, oxygen compressors, medication refrigeration, and cooling to maintain safe indoor temperatures for sensitive groups.	2024-2027	DILP, OCS
Assist efforts by existing commercial building owners to improve building resiliency by expanding C-PACE through new council legislation to meet the new options allowed by the state. Promote the use of C-PACE financing for improving building resiliency to flooding, heat, and other climate hazards.	2023	OCS

Action 4B: Promote existing programs to protect underserved populations from extreme heat and explore opportunities to expand eligibility for these programs to more people

Weatherization programs funded by federal and state grants provide free energy audits and energy efficiency upgrades, including new air conditioning units or air conditioning upgrades, to income-qualified individuals. Nonprofit organizations and contractors that manage these programs have expressed a need for additional outreach in Howard County to maximize use of the program. In addition, generators are critical resources to protect people during heat waves, but many people with lower incomes do not have access to them. It also is important to ensure that generators or other backup power sources have the lowest possible carbon footprint.

Overcoming Barriers

Not all income-limited populations may currently qualify for free weatherization assistance based on state guidelines, especially in Howard County where cost of living may be higher than in other parts of the state. In addition, many underserved populations are not able to access some of the County's quickest and easiest communications and outreach methods. County staff may need to work with partner organizations and employ new strategies to reach the populations that can most benefit from weatherization and related assistance.

Implementation

The Department of Community Resources and Services (DCRS) will be the lead implementer for this action, with support from the Howard County Health Department (Health), Office of Community Sustainability (OCS), and nonprofit partners such as the Community Action Council of Howard County and Civic Works.

Next Steps	Timeline	Responsibility
Review eligibility guidelines for weatherization programs and develop Howard County – specific educational materials as needed.	2023	DCRS
Review data documenting weatherization efforts in Howard County to date to determine any gaps in target populations or geographic areas that can be prioritized for focused outreach efforts.	2023-2024	DCRS, nonprofit partners
Reach out to service providers, companies, nonprofits, and other community leaders with influence in prioritized areas and targeted populations to request assistance with outreach and to coordinate efforts.	2023-2024	DCRS, Health
Conduct education and outreach campaigns for landlords, tenants, and homeowners, particularly in underserved and heat vulnerable communities, to promote existing weatherization programs, rebate programs, and grant programs to improve home comfort, energy efficiency, and adequate cooling systems.	Ongoing	DCRS, Health
Track participation in weatherization efforts and compare data collected before and after outreach campaigns to determine success.	Ongoing	DCRS, nonprofit partners
Explore opportunities to expand eligibility for people who do not currently qualify for weatherization services, but who have limited resources to take advantage of rebates and other available programs.	Ongoing	DCRS, OCS
Consider new incentives to reduce costs of energy audits, especially for low- and moderate- income households. Seek grant funding to cover the portion of energy audits not already covered by utility rebates.	Ongoing	DCRS, OCS, nonprofit partners
Explore opportunities to expand requirements for nursing homes and assisted living facilities to require smaller facilities to have emergency backup power that includes air conditioning as well as other critical health equipment.	Ongoing	OCS, Health
Assess the need for generators within under-resourced and heat vulnerable communities.	Ongoing	DCRS, OCS
Consider options to incentivize use of low carbon sources of backup power to make these options more affordable to residents and businesses. Low carbon backup power may include on-site solar with battery backup or renewable natural gas generators in place of diesel or gasoline generators.	Ongoing	DCRS, OCS

Action 4C: Promote and incentivize building best practices that protect people from impacts of extreme heat

Building best practices such as cool rooftops, green roofs, cool pavements, and shade plantings, can reduce heat island effects and protect heat-prone areas from increased intensity and duration of heat waves. However, these practices are not yet widely adopted. Incentives, case study projects, and improvements to regulations and design manuals can help increase the benefits of these practices relative to their costs.

Overcoming Barriers

Cost can be a significant barrier to some of these practices. Others of these practices may require frequent and/or complex maintenance. The County also needs to consider and address how to balance different possible uses for rooftops and parking lots and their benefits, such as solar panels and shade trees.

Implementation

The Department of Inspections, Licenses, and Permits (DILP) and the Office of Community Sustainability (OCS) will be the lead implementers for this action, with support from Department of Planning & Zoning (DPZ), Howard County Economic Development Authority (EDA), Department of Finance (Finance), and Department of Public Works (DPW).

Next Steps	Timeline	Responsibility
Research creative incentive programs, new requirements, and other options to increase the resiliency of new developments. Consider including resiliency-focused elements into any revisions of the Green Neighborhood Program.	2023-2024	OCS, DPZ, DILP, Finance
Convene a meeting with property developers in Howard County to discuss building practices and possible incentives that will successfully increase the resilience of new developments.	2024	OCS, DPZ, EDA, Finance
Consider adopting specific code revisions that may include green roofs, cool roofs, or solar photovoltaic roofs and cool and/or permeable pavements on driveways, paths, and other private roads, particularly in heat vulnerable areas. Determine whether additional inspectors or funding is needed to inspect these site components prior to issuing Use and Occupancy Permits. Obtain additional inspectors and/or funding as needed prior to implementing these code revisions.	2024-2025	DILP, DPZ, OCS
Consider updates to the Design Manual and/or Landscape Manual that include best management practices for heat resiliency.	2024-2025	DPW – Engineering, DPZ, DILP, OCS
Following any Design Manual and/or Landscape Manual updates, implement pilot projects on public properties owned and maintained by Howard County to serve as a model to private developments and property owners for how to incorporate heat resiliency best management practices into their projects. Promote these pilot projects and lessons learned through videos, websites, printed brochures, and tours.	2025-2027	DPW – Facilities, OCS

Action 4D: Improve resilience of critical infrastructure to flooding, heat and other climate hazards

Roads, bridges, dams, public water and wastewater utilities, and other critical infrastructure may experience additional stress from more extreme heat, flooding, and other climate hazards. Mapping flood risks to roads, dams, bridges, and other infrastructure can help the County identify and prioritize any needed improvements to existing infrastructure. Evaluating and considering updates to design requirements for infrastructure and critical facilities can help ensure resiliency to climate hazards. Retrofits of existing infrastructure to improve resiliency should prioritize buildings, roads, bridges, and other infrastructure critical to public health and safety and that provide services to under-resourced communities.

Overcoming Barriers

Retrofits of existing infrastructure can have a high cost, making prioritization critical. The County may need to identify outside sources of funding before pursuing some of these projects.

Implementation

Office of Emergency Management (OEM) and Department of Public Works (DPW) will be the lead implementers for this action, with support from Office of Community Sustainability (OCS).

Next Steps	Timeline	Responsibility
Continue to identify, map, and track critical infrastructure such as roads, bridges, dams, and public water and wastewater utilities that may experience stress from climate hazards.	Ongoing	OEM, DPW – Engineering, DPW – Utilities
Evaluate risks to infrastructure from climate hazards such as flooding, extreme heat, and severe storms. Create a priority list of infrastructure to target for resiliency upgrades. Priority should be given to at-risk critical infrastructure that provides services to under-resourced communities.	2023-2024	OEM, DPW – Engineering, DPW – Utilities, OCS
Apply for grants, loans, incentives, and other funding sources to implement priority resiliency upgrades to infrastructure.	2024-2027	OEM, DPW – Engineering, DPW – Utilities, OCS
Implement priority resiliency upgrades to infrastructure as funding becomes available.	2025-2030	DPW – Engineering, DPW – Highways, DPW – Utilities
Review Design Manual and consider updates to ensure new critical infrastructure is constructed to best withstand additional stress of current and future climate hazards.	2024-2025	DPW – Engineering, DPW – Highways, DPW – Utilities

Action 4E: Implement microgrids throughout Howard County where feasible, prioritizing areas that meet critical community needs

A microgrid is a local power generation system that can operate independently of the utility grid. Microgrids often include a combination of solar panels, battery storage, natural gas generators, and system controls that work together to provide on-site power. Microgrids can improve electric grid resiliency by reducing demand on the grid during high energy use days. Careful siting of microgrids and other local energy generation and storage can ensure critical public safety functions and vital community services are available even during extreme heat, severe storms, and associated power outages.

Overcoming Barriers

Costs for microgrid projects can be significant, making prioritization critical. The County may need to identify outside sources of funding before pursuing some of these projects.

Implementation

The Office of Emergency Management (OEM) and the Department of Public Works (DPW) will be the lead implementers for this action, with support from the Office of Community Sustainability (OCS).

Next Steps	Timeline	Responsibility
Pursue federal and state grant funds to support the Howard County Government Campus microgrid in Ellicott City. This project would ensure uninterrupted public services in the case of emergencies, including police services, 911 and emergency operations, emergency recovery, and local emergency shelter capabilities. Include matching funds for grants in the County's FY24 capital budget and beyond as necessary.	2023-2024	OEM, DPW – Facilities, OCS
If federal and or state funding is granted and matching funds in the Howard County budget are approved, design and install the Howard County Government Campus microgrid.	2025-2028	DPW – Facilities
Convene meetings with relevant stakeholders to understand where additional microgrid systems would be most beneficial for emergency operations and community services.	2023-2024	OEM, DPW – Facilities
Using feedback from stakeholder meetings and critical facilities mapping tools, establish a priority list of facilities for microgrid implementation. These may include facilities responsible for emergency communications, hospitals, public schools, and resource centers. Potential microgrid sites also should be prioritized to favor traditionally underserved communities.	2024-2025	OEM, DPW – Facilities
Apply for federal and state funding and explore other financing options such as public-private partnerships and energy-as-a-service to design and implement microgrids in priority order.	2025-2028	OEM, DPW – Facilities, OCS
Design and install priority microgrids whenever feasible and when outside funding is available to match any County investments	2026-2030	DPW - Facilities, external partners

Action 4F: Implement resiliency hubs to meet critical emergency needs for the community

A resiliency hub provides community services during emergencies, including heating and cooling, medication refrigeration, device charging, and assistance with accessing additional emergency preparedness and recovery resources. During emergencies, community members may have needs for services beyond what is available at typical heating and cooling centers. Residents can benefit from in-person support accessing resources to help with longer term emergency recovery, such as completing flood insurance claim forms and researching options for temporary housing, accessing emergency repair services, and more. Resiliency hubs provide safe places for the public to gather, meet critical needs, and gain information and assistance with emergency recovery. Resiliency hub services can include temporary access to heating and cooling, medication refrigeration, device charging, and assistance with accessing additional emergency preparedness and recovery resources. After a climate hazard event occurs with widespread power outages, having locations that residents can utilize for electricity, Wi-Fi, phone services, and emergency assistance will aid in recovery efforts.

Howard County's Community Centers are well-situated to serve as resiliency hubs, as they already provide many services to the surrounding communities and have great potential to develop into more robust resiliency hubs for disaster recovery. Howard County currently has four Community Centers managed by the Department of Recreation and Parks: Roger Carter Community Center in Ellicott City, North Laurel Community Center in Laurel, Harriet Tubman Cultural Center in Columbia, and Gary J. Arthur Community Center in Glenwood. These locations currently serve as emergency heating and cooling centers and have emergency backup power through diesel generators.

Overcoming Barriers

There are several different definitions for resiliency hubs, so coming up with a clear definition and criteria will be critical. Increasing functionality of existing County facilities is a cost-effective way to start providing resiliency hubs. However, outside funding sources will be required if the County identifies a need for facilities to provide additional resiliency hubs.

Implementation

The Office of Emergency Management (OEM) will be the lead implementer for this action, with support from Department of Recreation and Parks (DRP), Department of Public Works (DPW), and Office of Community Sustainability (OCS).

Next Steps	Timeline	Responsibility
Develop criteria for what is most needed for resiliency hubs in Howard County.	2024	OEM, DCRS, OCS
Evaluate current capacity of Howard County's Community Centers to meet the resiliency hub criteria and identify gaps in current services.	2025	OEM, DRP
Develop plans, budgets, and timeframes for each Community Center to add services and upgrade facilities and staffing services as needed to meet the criteria for resiliency hubs.	2025-2026	OEM, DRP, DPW – Facilities
Pursue grant funding wherever possible to make any desired upgrades to Community Center facilities and staffing.	2025-2026	OEM, OCS
Implement facility enhancements and hire/train new staff as needed to support resiliency hub functions of Community Centers.	2027-2028	DPW, DRP

Action 4G: Expand recruitment and training for technicians to support HVAC, microgrids, and emergency generators

The implementation of microgrid systems and other on-site energy generation and storage will require technicians to learn new skill sets. At the same time, extreme storms and heat will place greater stress on HVAC systems and could trigger more power outages, increasing the need for experts who can install, repair, and maintain HVAC systems and generators. In addition, well-educated HVAC technicians can recommend the best options for energy efficiency and preventive maintenance that will extend the life of equipment and reduce stress on the grid. Workforce development programs can create a talent pipeline for trained and qualified staff to fill future roles in these fields in the public and private sectors.

Howard County's Office of Workforce Development and the Howard County Workforce Development Board work with business leaders and workforce development providers within Howard County to provide opportunities including apprenticeships and jobs skills programs. Howard County Department of Public Works also has an apprenticeship program for trades and is interested in continuing to train and develop the local workforce as Howard County Community College currently runs a Heating, Ventilation, Air Conditioning and Refrigeration Apprenticeship Program in partnership with Heating and Air Conditioning contractors of Maryland. The College is looking to expand this program and add additional programming on solar and battery storage and other resiliency and energy efficiency training programs through its new Center for Sustainable Excellence.

Through this action, Howard County will assess current and future demand for HVAC, emergency generator, microgrid, and solar with battery storage technicians and work with Howard County Office of Workforce Development, Howard Community College, Lincoln College of Technology, HCPSS Applied Research Lab, Howard County Economic Development Authority, Chamber of Commerce, relevant trade associations, and other partners to develop recruitment programs, trainings, education materials, and apprenticeship programs especially related to preventative maintenance, emergency repair, energy efficiency, and grid resilience.

Overcoming Barriers

Coordination between multiple partners will be critical to ensure maximum reach without duplication of efforts.

Implementation

The Howard County Office of Workforce Development (OWD) will be the lead implementer of this action, with assistance from the Howard County Economic Development Authority (EDA), the Department of Public Works (DPW), and other nonprofit and training partners.

Next Steps	Timeline	Responsibility
Research and compile current and future demands for HVAC, microgrid, solar with battery storage, and emergency generator technicians.	2023-2024	OWD
Convene stakeholders and potential partners to discuss research results, share information about existing training programs, identify any gaps or opportunities to enhance existing programs or develop new programs.	2024-2025	OWD, nonprofit and training partners
Connect stakeholders with partners, resources, technical experts, and promotional opportunities to enhance and promote existing training programs or development of new programs.	2025-2028	OWD, nonprofit and training partners
Assist partners with budgeting, identifying funding sources, and pursuing funding for new programs as needed.	2025-2028	OWD
Connect trained technicians with apprenticeships and job opportunities with local businesses.	2025-2028	OWD, EDA, DPW, nonprofit and training partners
Continue to evaluate programs, improve and evolve educational materials and trainings as technologies change, and set new goals.	2025-2028	OWD, nonprofit and training partners

Strategy R5: Reduce heat islands and increase shade in heat vulnerable areas

Heat is one of the most dangerous climate hazards to human health. Urban heat islands, the result of dark, heat-absorbing surfaces like asphalt streets and parking lots can add anywhere from 6°F to 12°F of additional heat. Reducing heat islands will have important health co-benefits as well, as heat can exacerbate other health issues such as COPD and asthma.

Thoughtfully planting native drought- and heat-resistant trees will also reduce watering needs and maintenance costs as average temperatures climb and extreme heat events become more prevalent. Shade structures and cool surface products are other methods that should be researched and utilized, particularly where trees are not feasible. Parking lot solar canopies can serve the dual purpose of creating shade and renewable energy. More about solar can be found in the energy strategies.

Why These Actions?

Taking strategic action in heat vulnerable areas should be data driven. Research into heat islands and the connection with underserved populations has begun during the creation of this plan, but a cross-department effort to refine these targets would be very beneficial. Using this data as a starting point, these actions will increase tree planting and the use of shade structures and cool surface technologies and inform planning policy.

Addressing Equity

Underserved populations will be the most affected by extreme heat. Increasing shade trees, shade structures and cool surfaces within heat vulnerable areas will bring equity into this implementation process. Increased tree canopy also has other physical and mental health benefits which should be equitable among communities.

Howard County Leading by Example

Howard County Government has a robust street tree program that maintains existing trees and replaces trees as needed. In 2022, 1,000 street trees were planted. The Department of Public Works, Division of Highways responds to public input about street trees through the TellHoCo app which creates data that can be geo-located. Howard County Government has also built some shade structures in parks and installed solar canopies. Parking lot solar canopies have been installed at the Little Patuxent Wastewater Treatment Plant and two more are underway, one at the Ken Ulman building and one at the East Columbia Library.

Howard County Recreation and Parks has several tree planting projects that involve the public, including Turf to Trees, Stream ReLeaf, the Annual Tree Giveaway, and Students Branching Out. As of 2023, Howard County Department of Recreation and Parks is starting a new Tree Canopy program that prioritizes underserved and lower tree canopy areas. The Office of Community Sustainability assists these efforts and has also planted trees on Howard County Housing Commission property and created the Trees for Bees program.

Action 5A: Research and map heat vulnerable areas with a focus on underserved populations

To be the most impactful and efficient, Howard County needs to set criteria and delineate heat vulnerable areas so that tree planting and maintenance can be targeted to these prioritized areas. This Climate Action and Resiliency Plan's heat vulnerability mapping correlates high heat areas with underserved populations specific to Howard County. Using this data, existing mapping resources and mapped tree canopy data as starting points, this action will clearly delineate which geographic areas the County should prioritize for reducing heat. Incorporating defining heat vulnerable neighborhoods and streets will enable County programs to have the most impact on increasing shade and decreasing heat islands.

Overcoming Barriers

There are many tools and resources that map underserved populations and tree canopy, so much so that they can be overlapping and overwhelming. Howard County has GIS specialists and an impressive collection of interactive maps that are available to the public. Howard County has also completed a study of tree canopy using the most advanced and most recent high-quality data available. This action will use existing research and mapping as a springboard to sort through the data and create a mapping resource for use across departments and by the wider community.

Tracking Progress

Progress will be tracked by the creation of heat-vulnerability mapping and its use.

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer and collaborate with the Department of Technology and Communication Services (DTCS), Department of Planning and Zoning (DPZ), and Department of Public Works (DPW-Highways).

Next Steps	Timeframe	Responsibility
Convene a working group across departments that is tasked with refining the heat vulnerability mapping started in this plan and incorporating it into the County's Geographic Information Systems used by departments.	2023	DTCS, OCS

Share research, criteria, and maps across departments with the intention of using the heat vulnerable areas to prioritize tree programs.	2023-2024	OCS, DTCS, DPZ, DPW – Highways
Once refined, consider using identified heat vulnerable areas in plan review. Consider that tree canopy and other native vegetation should be required at higher levels in heat vulnerable areas.	2023-2025	DPZ

Action 5B: Strategically increase tree planting in heat vulnerable areas on both public and private land

Howard County is projected to see increases in extreme heat due to climate change. There are several geographic areas throughout Howard County, that would benefit most from shade to reduce the impact of heat. This action will prioritize high heat risk areas for shade trees, especially in the locations identified under Action 5A. High heat risk areas correspond with underserved populations and areas within Howard County that typically see the most pronounced impacts of urban heat island effect and extreme heat events.

Many trees planted now will be full size by climate target years such as 2030 and 2050. Howard County has a 73.2% homeownership rate, and the majority of available planting space is on private property, so working with the public will be crucial to these efforts.

Overcoming Barriers

Budget and staff resources are the main barriers to increasing tree planting. Dedicating resources to tree maintenance is a particular challenge.

Tracking Progress

Progress can be tracked by the number of trees planted in heat vulnerable areas by Howard County Government and our non-profit and resident partners.

Implementation

The Office of Community Sustainability (OCS) will coordinate these efforts with the Department of Public Works (DPW) Facilities and Highways Divisions, and the Department of Recreation and Parks (DRP).

Next Steps	**Timeframe**	**Responsibility**
Leverage the Street Tree program to prioritize heat vulnerable areas. Seek grants such as Maryland's Urban Trees initiative to support this work.	2023-2025	DPW – Highways, OCS
Increase tree planting on private property in underserved communities. Howard County started a new Tree Canopy program in 2023 to work with homeowners to plant native shade trees on private property. Heat vulnerable, low tree canopy areas will continue to be prioritized.	2023-2025	DRP
Integrate shade trees into any new County facilities such as parks, playgrounds, and facilities. Maximize tree canopy in projects that fall within the heat vulnerable areas outlined in Action 5A.	2023-2024	DRP, DPW – Facilities
Include consideration for heat resiliency and underserved communities when evaluating and awarding County environmental grants.	Ongoing	OCS
Integrate shade trees and drought resistant vegetation into roadway construction projects such as Complete Streets.	2023-2024	DPW

Increase tree planting by homeowners through outreach, education, and connecting homeowners with tree planting incentives such as the Marylanders Plant Trees coupon, County tree planting programs, and giveaways. Continue to work with non-profits and schools on tree planting.	Ongoing	OCS, DRP

Action 5C: Research and incorporate use of shade structures and cool surface technologies in public amenities and spaces

Nature-based solutions have the most co-benefits, but as annual average temperatures and extreme heat waves continue to increase across the country, structural cooling practices and products also need to be used. Prioritize high heat risk areas for shade structures and cool surfaces in amenities such as playgrounds and other high use paved surfaces.

Overcoming Barriers

Prioritizing projects based on heat vulnerable areas is a new concept that will take some time to research and incorporate into policy. It needs to be balanced with other priorities and brought to the attention of County staff.

Tracking Progress

Progress can be tracked by the number of shade structures, solar canopies, and other cooling technologies.

Implementation

The Department of Recreation and Parks (DRP) will be the lead implementer in coordination with the Department of Public Works (DPW) and the Department of Planning and Zoning (DPZ).

Next Steps	Timeframe	Responsibility
Document the use of shade and surface cooling technology that is already used in Howard County and share this information across departments.	2023-2024	DRP, DPW
Based on existing practices and new research, incorporate the use of shade structures and surface cooling technology into newly built public amenities and when older amenities are upgraded. Prioritize amenities in heat vulnerable areas.	2024-ongoing	DRP
Update or create regulations, policies, and standard operating procedures to ensure that these heat-reducing practices are formally incorporated into County projects.	2024-2027	DRP, DPZ, DPW

Strategy R6: Increase installation and facilitate maintenance of stormwater best management practices on residential, commercial, and non-profit properties

Increase the installation and long-term maintenance of small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics, preserve natural features, and minimize the impact of land development on water resources. These best practices may include bioretentions, rain gardens, conservation landscapes, and tree canopy expansion. Howard County already promotes many of these practices through existing programs. At a residential scale the impact may be small when looking at a single example, however widescale adoption of these practices can help reduce stormwater load as the frequency and intensity of rain events

increases. On commercial and non-profit properties, opportunities for larger projects can provide for larger scale treatment, as well as demonstration projects for the community. Additional outreach and education can generate further support and widespread adoption of these practices, including focused efforts toward demonstration sites. There is a need for ongoing support and resources to ensure proper maintenance of smaller-scale stormwater practices as part of post 2003 development. Providing outreach and educational materials to private property owners will assist in effectively installing and maintaining climate resilient stormwater management practices and ensure longevity of projects. Pairing these materials with financial incentives will foster rapid and effective stormwater management of Howard County's private property.

Why These Actions?

These actions expand upon existing programs, increase equity, provide greater incentives and thereby more participation, and promote the resilience of existing best management practices (BMPs) through maintenance. These program partnerships provide opportunities for educating large numbers of residents, as well as implementing larger-scale stormwater projects on private property, which are not addressed through capital projects.

Addressing Equity

Prioritizing projects within underserved and under-resourced communities imparts equity to this strategy. Identifying underserved communities and neighborhoods within vulnerable watersheds can help guide the prioritization of this strategy. Increasing the installation of stormwater BMPs will benefit existing stormwater infrastructure and add resiliency to communities by reducing the impact of stormwater runoff on properties during frequent smaller storms.

Howard County Leading by Example

Howard County provides multiple programs to incentivize stormwater management through all sectors of the built community. CleanScapes, Howard County's existing residential stormwater incentive program, installs stormwater BMPs in areas that pre-date modern stormwater development regulations. Howard County convened a Commercial Stormwater Solutions Work Group in 2016 with final recommendations for developing incentives and increasing participation in stormwater projects within the commercial sector. Based on this work group, Howard County developed a Commercial Stormwater Partnership Program to work with property owners to implement and retrofit stormwater practices while recognizing various financial strategies to make participation realistic. The Nonprofit Watershed Protection Partnership strives to maximize stormwater treatment on nonprofit properties, as well as community outreach, while providing a credit to the Nonprofit Partners' annual Watershed Protection Fee. Howard County piloted the Community Stormwater Partnership Grant program in 2022. This grant provides a funding source for Nonprofit Watershed Protection Partners to install stormwater solutions on their properties as part of their Partnership requirements, as well as provides much needed financial support to HOAs looking to install stormwater practices on shared common space.

Action 6A: Expand the CleanScapes program to increase installation and maintenance of stormwater practices on residential properties, with a focus on areas of high flood risk as well as underserved communities

Expand the CleanScapes program and related initiatives that increase the use of stormwater BMPs on residential properties. Broaden CleanScapes outreach efforts to target vulnerable watersheds and underserved communities; incorporate flood education resources into residential site visits by all Departments. Provide funding support for reconstructing BMPs that have reached the end of their life cycle.

Overcoming Barriers

Small-scale stormwater practices have the potential to make a big impact in terms of reducing stormwater runoff from frequent small storms, with the biggest potential coming from aggregating BMPs in areas where there is frequent flooding from lot-to-lot drainage. This approach to installation is challenging because not all homeowners will be willing

or able to participate, and focused outreach and education will be needed to make an impact, including increasing equity through new incentive programs.

Tracking Progress

The CleanScapes program will continue to be tracked through the number of BMPs installed and impervious surface reduction credits.

Implementation

The Office of Community Sustainability (OCS) will lead these actions and coordinate with the Department of Public Works (DPW).

Next Steps	Timeframe	Responsibility
Refine CleanScapes education and outreach materials to expand on the ecological and flood prevention benefits of these best practices, including maintenance information and resources.	Ongoing	OCS
Disseminate educational and outreach materials to property owners and community organizations, including those situated in vulnerable watersheds and underserved communities.	2023	OCS, DPW
Revise budgets as needed to account for program expansion. Hire/train new staff as needed to support program expansion.	Ongoing	OCS
Conduct workshops for landlords, tenants, realtors, and homeowners, particularly in underserved, flood-prone communities, and vulnerable watersheds to promote CleanScapes program.	Ongoing	OCS, DPW
Conduct ongoing research of new or innovative BMPs that can be included in the program and analysis of how to allow for increasing BMP quantity treatment.	Ongoing	OCS, DPW
Develop a BMP maintenance and reconstruction component of the CleanScapes program. Include considerations for post-2003 BMP installations that have reached the end of their life cycle.	2024-2025	OCS, DPW
Connect contractors to resources and technical experts to enhance and promote existing training programs or develop new programs.	Ongoing	OCS
Explore opportunities to expand eligibility for residents with varying income levels.	Ongoing	OCS

Action 6B: Enhance the Community Stormwater Partnership Grant program to further support stormwater best management practices in flood-prone areas, vulnerable watersheds, and underserved communities

Non-profits and HOAs are private landowners that tend to have large open space areas available for installation of stormwater practices. These sites also offer the potential for larger projects that are predominantly in shared spaces and provide an opportunity for educational signage to further community acceptance of nature-based stormwater solutions.

Overcoming Barriers

Stormwater solutions for nonprofits and HOAs are not currently provided through other means. This grant will aid these groups looking to treat stormwater runoff but struggling to fund projects. The effort will increase awareness and education to garner greater community support for stormwater treatment.

Tracking Progress

The number and dollar amount of grants awarded will be tracked each year.

Implementation

The Office of Community Sustainability (OCS) will implement these actions.

Next Steps	Timeline	Responsibility
Expand outreach and funding for the grant program to encourage new participation.	Ongoing	OCS
Incentivize or require Nonprofit Watershed Protection Partners to participate in the grant program.	Ongoing	OCS
Connect stakeholders with partners, resources, and technical experts to enhance and promote stormwater implementation.	Ongoing	OCS
Continue to include scoring for underserved communities and vulnerable watersheds in the grant review process.	Ongoing	OCS

Action 6C: Expand Commercial Stormwater Solutions Program to provide flexibility in program structure and account for the financial impacts of BMP installation and retrofits to property owners

Commercial properties have large areas of impervious surfaces and therefore can contribute significantly to stormwater runoff. Working with commercial properties also offers the opportunity for innovative projects, as seen through previous partnerships.

Overcoming Barriers

In most cases, stormwater treatment is not the focus of commercial property owners. Further, the current structure of the Watershed Protection and Restoration Fee and affiliated credit opportunities are rarely enough of an incentive for commercial properties to install or retrofit stormwater practices. Because of this, providing education and a variety of incentive options will encourage partnerships with the County.

Tracking Progress

The number of commercial partners and the impervious acre treatment credits provided through stormwater management installations or retrofits will continue to be tracked.

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer with assistance from the Department of Public Works (DPW).

Next Steps	Timeline	Responsibility
Research creative incentive programs, new requirements, and other options for commercial properties.	2024	OCS
Consider reconvening Commercial Stormwater Task Force to discuss incentives that will successfully increase the participation in the program.	2024-2025	OCS
Develop plans, budgets, and timeframes required for implementing participation incentives.	Ongoing	OCS

Consider implementing new incentives for properties that implement stormwater best practices.	Ongoing	OCS,
Continue to implement pilot projects on public properties owned and maintained by Howard County to serve as a model to private developments and property owners. Promote these pilot projects and lessons learned through videos, websites, printed brochures, and tours.	Ongoing	OCS, DPW

Action 6D: Provide BMP maintenance support and resources that ensure long term success of BMPs installed as part of new development

Providing resources and maintenance support to property owners, especially residential properties, who have BMPs installed on their property as part of the development process will address the long-term functionality of these systems. This is critical to ensuring that stormwater runoff from new developments is not negatively impacting local waterways and existing stormwater infrastructure. Howard County's existing Watershed Protection and Restoration Fund needs to provide for an increased maintenance component for both large and smaller stormwater practices.

Overcoming Barriers

Property owners often struggle with BMP maintenance typically because of lack of understanding or available resources and funds to support the maintenance efforts. Unmaintained BMPs neglect to provide water quality treatment and can exacerbate water quality concerns if left to erode.

Implementation

The Office of Community Sustainability (OCS) will coordinate this effort with the Department of Public Works (DPW) and the Department of Planning and Zoning (DPZ).

Next Steps	Timeline	Responsibility
Develop criteria for what is most needed; BMP types, maintenance frequency, new install vs. long-term maintenance.	Ongoing	DPW, OCS
Hire/train new staff as needed to support action.	Ongoing	OCS, DPW
Connect contractors to sustainable landscaping resources and technical experts to enhance and promote existing training programs or develop new programs.	2023-Ongoing	OCS, DPW
Convene meetings with developers to determine the best way to disseminate BMP maintenance information.	2024	OCS, DPZ
Create a guide for developers to integrate BMP maintenance information into their sales.	2024-2025	OCS, DPZ
Develop a real estate outreach campaign for property owners purchasing sites with existing stormwater facilities.	2024-2025	OCS, DPW

Action 6E: Leverage existing Nonprofit Watershed Protection Partners to implement stormwater management and outreach

The existing Nonprofit Watershed Partnership should be reevaluated to be more effective. Nonprofit Partners are currently very inactive, and few have installed or retrofit practices on their properties. This Partnership provides an opportunity to work with nonprofits and utilize their lands to provide greater stormwater management.

Overcoming Barriers

Howard County's existing Watershed Protection and Restoration Fund provides a credit of 100% to nonprofits joining the Partnership, however more parameters and requirements would make the Partnership more effective.

Tracking Progress

The Nonprofit partnership will be tracked by number of participants and their project implementation.

Implementation

The Office of Community Sustainability (OCS) will implement these steps.

Next Steps	Timeline	Responsibility
Research and propose additional parameters and requirements for the Partnership.	2023-2024	OCS
Develop criteria for what is most needed to increase participation in nonprofit stormwater implementation efforts.	2023-2024	OCS
Hire/train new staff to support the Partnership and assist in securing additional funding for projects.	Ongoing	OCS
Develop an outreach and assistance program for Partners.	2024-2025	OCS

Strategy R7: Prioritize stormwater management by strengthening regulations, policies, and innovation

Implement climate resilient stormwater management regulations, policies, and programs utilizing the best available climate science and best practices to design stormwater systems for forecasted future climate conditions. Strengthen existing initiatives, update infrastructure, incorporate new maintenance efforts, and ensure adequate funding.

Why These Actions?

As weather events continue to become more severe and intense, greater stormwater management is needed throughout the County, especially in flood prone areas. These actions will promote a synchronized approach to future policy and regulation changes. Improving infrastructure, and adjusting design guidelines to incorporate climate change projections, will restore and create new functionality within the stormwater management system and effectively prepare Howard County to withstand increased climate impacts. This will reduce the need for service repairs and the impacts of flooding on homes, business operations, utility infrastructure, and buildings.

Utilizing innovative and nature-based systems to maximize stormwater treatment options will increase co-benefits and added resiliency. Additional funding is needed to be able to provide necessary maintenance, upgrades, and additional infrastructure and treatment facilities.

Addressing Equity

Prioritizing stormwater improvements in underserved and under-resourced communities who are simultaneously situated within floodplains or frequently flooded areas will bring equity to this implementation process. Prioritizing these locations ahead of well-resourced areas increases the overall equity of this strategy.

Howard County Leading by Example

A Stormwater Subcabinet previously met to discuss issues and ideas and established the precedent to work across agencies on stormwater management issues, policies, and practices. Howard County continues to work across departments on stormwater projects regularly to ensure the greatest outcome and co-benefits.

Action 7A: Develop a Howard County specific stormwater management guide

Develop an understanding of what presently works well to combat issues related to stormwater management and what perceived gaps might be filled by innovative and new strategies. Package the findings of pilot projects, past experiences, priorities, funding options, and policies for Howard County staff into a guidance document. The document should also include forecasting for future weather events and how our stormwater management can adapt and be prepared, as well as any associated policy or regulation adjustments needed for resiliency. Fund a study of possible innovative solutions and strategies, including examples of what has worked and failed elsewhere.

Overcoming Barriers

The Maryland Stormwater Design Manual**,** prepared by MDE, provides performance criteria and design specifications for a variety of stormwater infrastructure throughout Maryland. A Howard County specific guide could provide insight into the most successful project types and applications, areas where our regulations differ from the state, and priorities for implementation both in terms of locations and types of practices. The guide can provide an overview of the operations and maintenance costs and protocols for new stormwater management techniques or strategies not outlined in detail by MDE.

Implementation

The Office of Community Sustainability (OCS) will be the lead implementer in close coordination with the Department of Public Works (DPW) and with input from the Department of Planning & Zoning (DPZ).

Next Steps	Timeline	Responsibility
Strategize on funding sources to secure a consultant team to assist in creating a Howard County Stormwater Guide.	2023	OCS, DPW
If funding is secured, procure a scope that requests the creation of a guide with specific attention on innovative stormwater management practices and climate resilience.	2024-2025	OCS, DPW
Produce the guide and include best practices using consultant expertise and stakeholder engagement with operations and maintenance departments and any departments working within the stormwater management space.	2025	OCS, DPW, DPZ
Continue to adjust and update the guide and keep staff aware of new projects and techniques.	2025-ongoing	OCS

Action 7B: Consider adjusting and strengthening stormwater management regulations based on climate change predictions

Consider increasing stormwater management regulations for redevelopment, as well as expanding special stormwater management zones requiring higher treatment levels for watersheds with known or predicted flooding. Also consider increasing stormwater treatment requirements based on scientific predictions for future weather events.

Overcoming Barriers

Howard County currently follows MDE guidance for water quality and quantity for stormwater management, however greater regulations may be needed with increasing storm events and flooding areas.

Implementation

The Office of Community Sustainability (OCS), Department of Public Works (DPW), and Department of Planning & Zoning (DPZ) will coordinate on this effort.

Next Steps	Timeline	Responsibility
Coordinate between agencies to determine realistic options for strengthening regulations.	Ongoing	OCS, DPZ, DPW
Develop policy or legislation as needed to update regulations in coordination with Maryland Department of the Environment's Advancing Stormwater Resiliency in Maryland (A-StoRM) report.	Ongoing	DPW, OCS, DPZ

Action 7C: Increase support for maintenance and infrastructure updates

Provide funding dedicated to maintenance of existing stormwater management infrastructure, including storm drains, environmental site design practices, and stormwater ponds. Prioritize funding and action based on climate predictions and proximity to vulnerable watersheds and underserved populations.

Overcoming Barriers

Currently very little funding is available for maintenance and inspections of facilities and storm drain system upgrades. Storm drain systems are reaching end of life and will continue to fail without replacements causing severe damage and safety concerns. New Environmental Site Design (ESD) practices installed will fail without proper maintenance leading to poor water quality and increased runoff impacts. The large quantity of required ESD practices requires an increase in funding for inspections as well.

Tracking Progress

All facilities will continue to be inspected triennially and the status and expected life span of each will be tracked to ensure maintenance is occurring and being prioritized on critical facilities.

Implementation

The Department of Public Works (DPW) will be the lead implementer with assistance from the Office of Community Sustainability (OCS) and Howard County Public School System (HCPSS).

Next Steps	Timeframe	Responsibility
Research funding needs to provide critical inspections, maintenance, and upgrades of infrastructure.	2023 - Ongoing	DPW
Research and pilot additional workforce development opportunities and employment efforts to increase labor available for needed maintenance and inspections.	Ongoing	DPW
Coordinate with HCPSS to provide training for grounds staff who maintain stormwater BMP's on HCPSS property.	2023-Ongoing	OCS, DPW, HCPSS
Continue to implement innovative strategies that may reduce maintenance needs.	Ongoing	DPW, OCS
Establish inclusion of additional funding and a long-term funding strategy to be adopted through the annual County budget process.	2023-Ongoing	DPW, OCS

Action 7D: Employ innovation and natural solutions in stormwater management

Seek opportunities to employ innovative best practices to maximize stormwater quantity and quality control within existing stormwater management infrastructure and/or for creating new stormwater storage capacity on already developed land. Consider natural solutions prior to structural solutions in all cases and only select structural solutions after careful analysis and elimination of alternatives.

Overcoming Barriers

While structural and engineered solutions are more commonplace and familiar, innovative and natural practices often have a greater potential for providing multi-benefit solutions, such as water quantity and quality treatment, while also providing habitat or carbon sequestration and should be chosen over structural solutions in all possible opportunities.

Implementation

The Office of Community Sustainability (OCS) will coordinate these efforts with the Department of Public Works (DPW).

Next Steps	Timeframe	Responsibility
Research best practices and innovative ideas that have been piloted in other communities and look to pilot or adapt them in Howard County.	Ongoing	OCS, DPW
Develop a checklist, SOP, or policy to assess the practicality of nature-based solutions for each project and prioritize these practices over structural whenever appropriate.	2024	OCS, DPW
Continue to look for new opportunities to incorporate stormwater management and nature-based solutions in other County projects (such as road work, complete streets, and development) or including additional stormwater management above what is required.	Ongoing	OCS, DPW
Provide increased support (staff and funding) for the commercial stormwater partnership program and nonprofit partnership program to allow new partnerships and innovative implementation options on private property.	Ongoing	OCS

Action 7E: Establish a fund for pilot projects to encourage innovation

Establish a fund to support pilot projects that test new solutions on a small scale. Establish baseline performance of pilot projects and develop scalable plans to implement successful pilot projects throughout Howard County. Simultaneously, begin to identify local, state, and federal public and private resources that can fund large scale implementation programs. Pilot projects are an effective initiative to understand the benefits of innovative stormwater management practices, while also piloting the cost, operations, and maintenance required to steward such stormwater management infrastructure.

Overcoming Barriers

Pilot projects and new partnerships can sometimes be overlooked if clear funding isn't available to test new solutions and innovation. Dedicated funding for pilot projects allows for new partnership development and testing of innovative solutions.

Implementation

The Office of Community Sustainability (OCS) will lead this effort in close coordination with the Department of Public Works (DPW).

Next Steps	Timeframe	Responsibility
Establish a fund for the engineering design and construction of pilot projects in Howard County's annual budget cycle.	2024-2025	DPW, OCS
Utilize funds to implement and test innovative practices and partnerships.	Ongoing	OCS, DPW
If pilot projects are successful, integrate these stormwater management practices into large scale implementation programs.	Ongoing	OCS, DPW

Action 7F: Explore increasing the Watershed Protection and Restoration Fee, as well as alternative funding solutions

Consider a variety of fee increase structures and explore funding opportunities from private, state, and federal sources, as well as additional funding structures such as public private partnerships and cost share programs.

Overcoming Barriers

Current fee rates do not provide an incentive for larger private property owners to participate in stormwater treatment installation or upgrades. Howard County instituted a Watershed Protection and Restoration Fee in 2013, however it has yet to be updated to reflect inflation, maintenance needs, and impending greater treatment requirements because of severe weather.

Tracking Progress

The impervious surface treatment provided utilizing Watershed Fee revenue will continue to be tracked and reported to the State and County.

Implementation

The Office of Community Sustainability (OCS) will lead this effort in coordination with the Department of Public Works (DPW) and Department of County Administration (DCA).

Next Steps	Timeline	Responsibility
Work with consultant to provide various Fee structures to increase the revenue into the Watershed Protection and Restoration Fund.	2023	OCS
Provide outreach and education to residents and property owners regarding potential Fee changes.	2023-2024	OCS, DPW
Provide a proposal to the County Administration for Fee restructuring and introduce associated legislation.	2023	OCS, DCA, DPW
Explore other funding opportunities from various sources.	Ongoing	OCS, DPW

Action 7G: Improve reclaimed water capacity and usage

Rainwater and reclaimed water can be valuable resources during climate change. Howard County currently purchases all potable water from outside sources. Capturing and reutilizing rainwater greatly improves County-wide resiliency and reduces dependence on other sources for non-potable water needs. This will also reduce our demand on the regional water supply should neighboring jurisdictions face a water shortage or threat. Capturing rainwater and reclaimed treatment plant water to be repurposed, reduces stormwater flows as well as demand on infrastructure and potable water resources. This water can be utilized for a multitude of applications and be essential during severe storm or emergency events, drought, or if water systems are compromised.

Overcoming Barriers

Howard County piloted a few small-scale rainwater collection systems (cisterns) with mixed success, including at fire stations for truck washing. Learning from these efforts can improve our ability to be more water independent moving forward.

Tracking Progress

The amount of rainwater and reclaimed water redirected for other uses will be tracked.

Implementation

The Office of Community Sustainability will lead implementation of these actions in collaboration with Department of Public Works (DPW), Department of Inspections, Licenses, and Permits (DILP), and Department of Fire and Rescue Services (DFRS).

Next Steps	Timeline	Responsibility
Assess existing cistern systems and determine successes, failures, and use restrictions.	2024	OCS, DPW, DFRS, DILP
Where possible provide maintenance plans, repairs, or enhancements for existing systems.	2024-Ongoing	OCS, DPW, DFRS
Review current code language regarding water reuse (currently optional for Howard County) and explore expanding the County's reclaimed water systems for non-potable water requirements and potential future needs related to climate change, water independence, and community resiliency.	2024	OCS, DPW, DILP
Establish funding to support the expansion of reclaimed water usage and consider funding opportunities from various sources.	Ongoing	OCS, DPW

Strategy R8: Determine vulnerable watersheds and prioritize recommended stormwater solutions

Create a program focused entirely on Vulnerable Watersheds, defined as areas within the County subject to flooding both from overflowing streams and from local drainage systems inadequate to convey runoff from large storm events. As weather events continue to intensify, prioritize identifying, assessing, and implementing actions to aid these communities. Long term sustainability and maintenance of installed projects must be carefully considered and planned, including dedicated funding. Utilizing innovative and nature-based systems to maximize stormwater treatment options in these Vulnerable Watersheds will increase co-benefits and resiliency.

Why These Actions?

This action was chosen because increasing weather events will only exacerbate existing flooding concerns in certain areas of the County, and possibly cause flooding in new areas. Working to identify and reduce flooding by watershed will maximize the impact in the community.

Addressing Equity

To address flooding issues in vulnerable communities, we must first identify locations and potential solutions. This strategy calls for short and long-term planning and will include prioritizing stormwater improvements in underserved and under-resourced communities where frequent or severe flooding occurs.

Howard County Leading by Example

Howard County's existing small watershed plans and known past flooding experiences will help guide efforts in this program.

Action 8A: Establish a new program designed to aid Vulnerable Watersheds

Create a Vulnerable Watershed Restoration and Resiliency Program to assist communities with flooding issues, including severe erosion. Utilize a set of criteria to locate, assess, and implement recommendations to assist in flooding and its associated impacts. Prioritize recommended stormwater enhancements and maintenance in these areas of the County to create more resilient neighborhoods.

Overcoming Barriers

Proactive rehabilitation and improvements to stormwater infrastructure can reduce the impacts of heavy precipitation and flooding instances. Improving the functionality of these systems before a storm hits will effectively prepare Howard County to withstand these climate impacts. Ensuring dedicated funding is critical to creating an effective difference in these vulnerable watersheds.

Implementation

The Department of Public Works (DPW) will lead these actions with close coordination with the Office of Community Sustainability (OCS).

Next Steps	Timeline	Responsibility
Establish a fund for the Vulnerable Watershed Restoration and Resiliency Program through a budget request each year.	Ongoing	DPW
Seek outside funding opportunities such as grants and partnerships.	Ongoing	DPW, OCS
Develop criteria utilizing best available data and science to define and prioritize Vulnerable Watersheds.	2023	DPW, OCS
Provide a comprehensive analysis for each Vulnerable Watershed, including existing storm drainage and stormwater controls, noted concerns, predictions for future impacts due to increased weather events, and generate a list of strategies and projects to combat the drainage and flooding issues in each watershed.	2023-ongoing	DPW, OCS
Utilize the analysis to methodically implement effective projects that will increase stormwater management and reduce flooding. Each project should have a long-term plan for maintenance to ensure the sustainability of these efforts and maximize neighborhood resiliency.	2024-ongoing	DPW, OCS
Focus solutions on employing tools that work with natural systems and the existing land, and reducing gray infrastructure, when possible, to maximize co-benefits within the neighborhood.	Ongoing	DPW, OCS
Increase staffing or contractual awards as needed to continue progress.	Ongoing	DPW, OCS

Strategy R9: Maximize the resiliency benefits derived from ecosystem services by improving protections for wetlands, forests, and streams and increasing the acreage of these resources through restoration or creation

Ensure that the resiliency benefits provided by ecosystems are valued and protected. Healthy wetlands, forests, and streams mitigate environmental conditions more cost effectively than engineered systems and have greater co-benefits. These ecosystems absorb water and wind, mitigate heat, treat pollution, and perform many other ecosystem services essential to human health. These services are increasing in value as we prepare for a changing climate.

Why These Actions?

Wetlands, forests, and streams act as natural sponges and filters in the landscape. They absorb water and the energy that carries it during storms. They sequester carbon and remove or breakdown various pollutants from the air, ground, and water. These ecosystems provide countless additional services which need to be better understood and supported as we prepare for increased community stressors associated with climate change.

Addressing Equity

At risk and underserved populations often have fewer resources available to prepare for, and respond to, environmental hazards and disasters. As a result, these communities are more reliant on ecosystem services to mitigate conditions after an extreme weather event, and for maintaining quality of life in general as our climate continues to change.

Howard County Leading by Example

Howard County protects its natural resources through a combination of zoning and land development regulations, comprehensive plans, implementation manuals, habitat management plans, incentive programs and educational efforts. Together, these tools provide a system for protecting natural resources and the goods and services they provide, greatly contributing to Howard County's high quality of life. In preparation for the increased stressors from climate change, Howard County is always looking at new and improved measures for natural resource management, to improve the resiliency and mitigation capacity of our landscape and provide a healthy environment to the next generations.

Action 9A: Improve the protection of existing wetlands, restore degraded wetlands, and investigate wetland creation opportunities

Consider increasing buffers or other protections for wetlands, especially in vulnerable watersheds and near underserved populations. Investigate options for wetland preservation, restoration, and creation.

Overcoming Barriers

Many wetlands are on private land, but stormwater management and farm management practices lend themselves to opportunities to address the concerns of multiple stakeholders through wetland stewardship.

Implementation

Department of Planning and Zoning (DPZ) will manage buffer width assessments and other regulatory aspects of this action. The Office of Community Sustainability (OCS) will lead on researching sites for wetland preservation, restoration, and creation. The Department of Recreation and Parks (DRP) and Department of Public Works (DPW) will lead on implementation projects occurring on County property. Howard Soil Conservation District (HSCD) and Howard County Economic Development Authority (EDA) will assist with any implementation steps involving agricultural properties.

Next Steps	Timeframe	Responsibility
Consider increasing buffer widths for wetlands in flood vulnerable areas.	2025-2027	DPZ, OCS
Investigate opportunities for mitigation requirements to proposed impacts to wetlands or wetland buffers.	2025-2027	DPZ, OCS
Continue to work with developers to evaluate more environmentally friendly site design options when considering requests for alternative compliance to wetland regulations.	Ongoing	DPZ, OCS
Investigate opportunities for wetland protection, restoration, expansion, and creation across land uses. Partner with universities, nonprofits, agricultural property owners, and the environmental restoration industry.	Ongoing	OCS, DPZ, HSCD, EDA

Prioritize and begin implementation of the projects discovered in the investigation described above.	2025-2027	OCS, DRP, DPW, DPZ, HSCD, EDA
Explore new funding sources for implementation of wetland protection, restoration, and creation projects.	Ongoing	OCS, DRP, DPZ, DPW
Encourage developers to remove existing culverts, bridges, and structures within wetlands and their buffers, restore onsite wetlands, and maintain natural hydrology as part of site development.	Ongoing	DPZ, OCS, DPW
Consider creating a resource protection goal for wetlands and their buffers for each of the County's major watersheds.	2025-2027	DPZ, DRP, OCS

Action 9B: Improve the protection of existing forests, restore degraded forests, and increase forest acreage where possible. Retain and expand non-forest tree canopy

Use a variety of tools to protect and enhance the County's forest and tree canopy resources. Further research our forest needs. Look at different types of forests and tree canopy and how they might merit different levels of protection in preparation for climate change. Periodic updates of the Forest Conservation Act and Forest Conservation Manual, and funding for the upkeep of Forest Conservation Easements and other County owned, forested lands are all essential to successful forest protection in Howard County.

Overcoming Barriers

Much of the county's forest and tree canopy is located on property which is not owned by the County, but by private or Maryland state entities, limiting the County's influence over those properties. Forest fragmentation, prolific invasive species, and an overpopulation of deer are major threats to the long-term health of forest and tree canopy resources. Howard County's land holdings have increased considerably in the last 20 years and additional staff and funding is needed to manage the extensive forested lands owned by the County.

Implementation

The Department of Recreation and Parks (DRP) and the Department of Planning and Zoning (DPZ) are the lead departments responsible for the protection of forest resources. The Office of Community Sustainability (OCS) and Department of Public Works (DPW) play a supporting role in many of the departmental forest management efforts.

Next Steps	Timeframe	Responsibility
Increase the maintenance of existing forest resources on County land.	Ongoing	DRP, OCS
Provide incentives for maintenance of existing forests on private property.	2026	OCS, DRP
Prioritize opportunities to protect and expand forests in climate vulnerable and underserved communities.	Ongoing	OCS, DRP, DPZ
Develop partnerships with state and federal agencies to manage forests on public, non-county property.	2025	OCS, DPW, DRP
Continue to work with developers to evaluate more environmentally friendly site design when considering requests for alternative compliance to the Forest Conservation Act.	Ongoing	DPZ, OCS, DRP
Evaluate the effects of recent updates to the County and State Forest Conservation Acts and consider updates to the County Forest Conservation Act and Forest Conservation Manual to address any gaps in tree protection during the development process.	2023-2030	DPZ, DRP, OCS
Keep abreast of and advocate for state and federal programs that offer incentives for preserving forests such as forest banking and carbon credits.	Ongoing	OCS, DPZ, DRP
Increase non-forest canopy.	Ongoing	DRP, OCS, DPW

Develop funding avenues to hire additional natural resource focused staff for Forest Conservation Easement inspections, forest maintenance, public outreach, and other emerging needs.	Ongoing	OCS, DRP, DPZ
Investigate new methods of controlling the overpopulation of white-tailed deer.	2024	DRP, OCS, DPZ
Encourage the removal of invasive species in development projects.	Ongoing	DPZ, DRP, OCS
Investigate measures to improve the onsite retention of higher quality forests and connections between larger forest patches.	Ongoing	DPZ, OCS, DRP
Consider creating a resource protection goal for forests and tree canopy for each of the County's major watersheds.	2025-2027	DPW, DPZ, DRP, OCS

Action 9C: Improve the protection of streams, restore degraded streams, and increase stream buffers where possible

Improving stream resiliency benefits to developed areas and ecosystems. The ability of stream systems to absorb and retain water volume and dissipate erosive energy is reliant on the health of the stream prior to a severe weather event. Streams that are connected to their floodplains and streams with forested banks and buffers are more resilient to extreme weather and provide greater resiliency benefits to surrounding developments.

Overcoming Barriers

Watersheds comprise large areas with many different property owners and land uses, which contribute to or detract from stream health. Many stakeholders prefer to be able to utilize streams and stream buffers in ways that may complicate their protection, including commercial development, farming, and residential uses.

Implementation

The Department of Planning and Zoning (DPZ) will lead on regulatory aspects of stream protection. The Department of Public Works (DPW), Department of Recreation and Parks (DRP), and Office of Community Sustainability (OCS) play various implementation roles in stream protection and restoration.

Next Steps	Timeframe	Responsibility
Consider increasing buffer widths for streams in flood vulnerable watersheds, underserved populations, or other defined areas as a part of any future code updates.	2025-2027	DPZ, OCS
Continue to work with developers to evaluate more environmentally friendly site design when considering requests for alternative compliance to stream and stream buffer regulations.	Ongoing	DPZ, DRP, OCS
Research streams with potential for improved buffers and floodplain connections, particularly in flood vulnerable and underserved communities. Partner in this effort with nonprofits, environmental restoration companies, universities, and other private entities as appropriate.	Ongoing	OCS, DPW, DRP, DPZ
Increase outreach to landowners with potential to improve stream buffers and connect landowners with resources to incentivize buffer planting.	2025-2026	OCS, DRP
Increase funding available for this action by expanding existing funding sources and exploring and applying for new funding sources.	Ongoing	OCS, DPZ, DRP
Encourage the removal of invasive species within stream buffers.	Ongoing	DPZ, OCS, DRP

Encourage developers to remove existing culverts, bridges, and structures within streams and their buffers, and restore streams as part of site development.	Ongoing	DPZ, OCS, DPW, DRP
Prioritize forest retention and native planting in floodplains and riparian areas.	Ongoing	DPZ, DRP, OCS
Investigate opportunities for mitigation requirements to proposed impacts to streams and stream buffers.	2025-2027	DPZ, OCS, DRP
Consider creating a resource protection goal for stream buffers for each of the County's major watersheds.	2025-2027	DPZ, DPW, OCS
Consider expanding the scope of watershed management plans to set priorities and guide efforts to protect, restore, and improve the County's environmental resources.	2025-2027	DPW, DPZ, OCS

Action 9D: Protect and enhance the natural resources in the Green Infrastructure Network

Connectivity between ecosystems is critical for their health and function, especially in the wake of a natural disaster or with shifting climate patterns. After a major disturbance such as fire, flood, or an insect invasion, ecosystems which are connected to healthy ecosystems will recover more quickly than areas without those connections. Similarly, if shifting weather patterns degrade an ecosystem in one location, such as the long-term drying of a wetland, the Green Infrastructure Network (GIN) provides potential routes for species to emigrate to other locations. The plant and animal species in the GIN rely on its connectivity for their long-term vitality, and human populations rely on the ecosystem services provided by these species and their associated ecosystems.

Overcoming Barriers

Much of the land in the GIN is privately owned, limiting the County's influence over those properties. The GIN does not currently have any specific legal protection; however, most of the land in the GIN is already protected.

Implementation

The Department of Planning and Zoning (DPZ) leads the overall management of the GIN Program including updating the GIN Map and GIN Plan. The Department of Recreation and Parks (DRP) manages the natural resources present on County owned properties as well as the acquisition of properties for conservation purposes. The Office of Community Sustainability (OCS) supports the GIN Plan by exploring new funding and stewardship opportunities for GIN related projects and educating the public about the GIN.

Next Steps	**Timeframe**	**Responsibility**
Use the guidance in the GIN Plan to determine the most desirable land or easement purchases in the GIN.	Ongoing	DPZ, OCS, DRP
Purchase easements or land in the GIN.	Ongoing	DPZ, OCS, DRP
Continue to implement the GIN Plan using the tools of stewardship, financial incentives, regulatory protection, easements, and acquisition.	Ongoing	DPZ, OCS, DRP
Research additional implementation options and regulatory measures to those presented in the GIN Plan.	Ongoing	DPZ, OCS, DRP
Increase funding available for this action by expanding existing funding sources and exploring and applying for new funding sources.	Ongoing	OCS, DPZ, DRP

Action 9E: Ensure that planting practices evolve to be resilient to climate change

Assess planting pallets across County programs, including the development of new County facilities, land development regulations, tree planting programs and other environmental incentive programs such as CleanScapes.

Overcoming Barriers

Guidance regarding which plants to use in projects ranging from forestation to landscaping, with respect to a changing climate, is limited but emerging as land managers predict the need to reevaluate planting plans and management methods moving forward.

Implementation

The Department of Recreation and Parks (DRP), Department of Public Works (DPW), Department of Planning and Zoning (DPZ), and Office of Community Sustainability (OCS) will share knowledge gained while considering updates to the plants recommended or accepted for use in their programs.

Next Steps	Timeframe	Responsibility
Research the latest science on the best trees and landscape plants that are adaptable to a changing climate and incorporate these findings into existing County programs. Increased heat, drought, and intense rain events are specific concerns.	2023-2025	DRP, OCS, DPZ
Update the Landscape Manual and include considerations for heat, drought, and intense rain events. Increase requirements for native plants and prohibit the use of invasive species.	2023-2025	DPZ, OCS, DRP
Provide resources to educate and guide County staff, developers, landscape professionals, and other stakeholders about updated best practices, new landscaping requirements, and the reasons for their use.	2025-2026	DPZ, OCS, DPW
Determine if updates are needed for required and recommended planting guidelines that are not covered in the Landscape Manual.	2025-2026	DRP, DPZ, OCS

Appendices

- **Appendix A: Strategy and Action Summary**
- **Appendix B: Glossary**
- **Appendix C: Climate Vulnerability Assessment Methodology**
- **Appendix D: Climate Emergency Preparedness Survey Summary**
- **Appendix E: Greenhouse Gas Emissions Inventory Methods**
- **Appendix F: Mitigation Analysis Assumptions and Methods**
- **Appendix G: Current Howard County Climate Initiatives**

[1] Baltimore Metropolitan Council and Baltimore Regional Transportation Board. Planning, Designing, Operating, and Maintaining Local Infrastructure in a Changing Climate. 2021. https://www.baltometro.org/sites/default/files/bmc_documents/general/transportation/climate-change/Climate%20Change%20Resource%20Guide.pdf

[2] The Columbia Association. *Climate Vulnerability Assessment Columbia, Maryland*. 2021. https://www.columbiaassociation.org/wp-content/uploads/2022/01/CA-Climate-Vulnerability-Assessment-121021.pdf

[3] The climate projections cited from the BMC study assume RCP 8.5. For more information about their analysis assumptions, please refer directly to that report.

[4] BMC (2021) defines *heatwaves* as 3 consecutive days above the 98th percentile temperature.

[5] Data from the Climate Toolbox (https://climatetoolbox.org/tool/Climate-Mapper) indicates Howard County's minimum relative humidity during the summer to be around the mid-40s, averaged over the time period 1971-2000; maximum relative humidity can climb into the 90s. Relative humidity tends to fall as temperatures climb, so the minimum relative humidity levels would more likely occur during the maximum temperatures in a day. There is variation across the County and across days and years, but suffice to say, Howard County often experiences high humidity levels during the summer, and that these levels are sufficient to create heat index levels of Dangerous or Extremely Dangerous.

[6] National Weather Service. What is the heat index? https://www.weather.gov/ama/heatindex

[7] BMC (2021) defines *extremely heavy precipitation* event as 95th percentile of days with precipitation. In more simple terms, when looking at all of the days in a given year that had some precipitation, it is the amount of precipitation that the 5% of the highest precipitation days exceed. So, if 100 days in a year had at least some precipitation, the 5 rainiest (or snowiest) days would be considered *extremely heavy precipitation* events.

[8] U.S. Geological Survey, Water Science School. The 100-Year Flood. (2018) https://www.usgs.gov/special-topics/water-science-school/science/100-year-flood#:~:text=The%20100%2Dyear%20recurrence%20interval,year%20is%201%20in%20100.

[9] National Weather Service. Ellicott City Historic Rain and Flash Flood – July 30, 2016. https://www.weather.gov/lwx/EllicottCityFlood2016

[10] U.S. Global Change Research Program. Fourth National Climate Assessment: Volume II: Impacts, Risks, and Adaptation in the United States. 2018. https://nca2018.globalchange.gov/

[11] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service. *The Historic Derecho of June 29, 2012.* 2013. https://www.weather.gov/media/publications/assessments/derecho12.pdf

[12] Kretschmer M, et al. More-Persistent Weak Stratospheric Polar Vortex States Linked to Cold Extremes. Bulletin of the American Meteorological Society. 99 (1): 49-60. 2018. https://doi.org/10.1175/BAMS-D-16-0259.1

[13] Zhang P, et al. Prolonged Effect of the Stratospheric Pathway in Linking Barents–Kara Sea Ice Variability to the Midlatitude Circulation in a Simplified Model. Climate Dynamics. 50: 527-539. 2018. https://doi.org/10.1007/s00382-017-3624-y

[14] Overland J, et al. The Melting Arctic and Midlatitude Weather Patterns: Are They Connected? Journal of Climate. 28 (20): 7917-7932. 2015. https://doi.org/10.1175/JCLI-D-14-00822.1

[15] Kim B, et al. Weakening of the Stratospheric Polar Vortex by Arctic Sea-ice Loss. Nature Communications. 5, 4646. 2014. https://doi.org/10.1038/ncomms5646

[16] Baltimore Metropolitan Council. 2022. "Vulnerable Populations Index". https://www.baltometro.org/transportation/data-maps/vulnerable-populations-index. Accessed August 2022.

[17] The Columbia Association. *Climate Vulnerability Assessment Columbia, Maryland*. 2021. https://www.columbiaassociation.org/wp-content/uploads/2022/01/CA-Climate-Vulnerability-Assessment-121021.pdf

[18] State Highway Administration of Maryland. https://www.roads.maryland.gov/OPPEN/annual_vehicle_Class.pdf

[19] National Caucus of Environmental Legislators (NCEL). Maryland Passes the Climate Solutions Now Act. April 11, 2022. https://www.ncelenviro.org/articles/maryland-passes-the-climate-solutions-now-act/

[20] Powell, Michael C., Gordon Feinblatt LLC. The Climate Solutions Now Act of 2022. April 4, 2022. https://www.gfrlaw.com/what-we-do/insights/climate-solutions-now-act-2022#:~:text=The%20Climate%20Solutions%20Now%20Act%20%28SB528%29%20is%20arguably,Maryland%20economy%20to%20reach%20net-zero%20emissions%20by%202045.

[21] U.S. Department of Transportation. The Bipartisan Infrastructure Law Will Deliver for Maryland. April 13, 2022. https://www.transportation.gov/briefing-room/bipartisan-infrastructure-law-will-deliver-maryland#:~:text=Under%20the%20Bipartisan%20Infrastructure%20Law%2C%20Maryland%20would%20expect%20to%20receive,billion%20available%20for%20EV%20charging.

[22] Hawken, P. 2017. Drawdown. New York, NY: Penguin. p. 222

[23] University of Pennsylvania. Tipping point for large-scale social change. ScienceDaily. June 7, 2018. www.sciencedaily.com/releases/2018/06/180607141009.htm.

[24] Project Hawken, P. 2017. Drawdown. New York, NY: Penguin. p. 41

[25] Ibid., p. 42

[26] Ibid., p. 39, 42-43

[27] 2022 number of chargers found by using the AFDC Electric Vehicle Charging Station Locations map data and filtering for chargers located within Howard County. Data accessed on August 30, 2022. https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC

[28] Javid, Roxana J., Mahmoud Salari, and Ramina Jahanbakhsh Javid. "Environmental and Economic Impacts of Expanding Electric Vehicle Public Charging Infrastructure in California's Counties." Transportation Research Part D: Transport and Environment 77 (December 2019): 320–34. https://doi.org/10.1016/j.trd.2019.10.017.

[29] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. National Plug-in Electric Vehicle Infrastructure Analysis. September 2017. https://www.energy.gov/sites/default/files/2017/09/f36/NationalPlugInElectricVehicleInfrastructureAnalysis_Sept2017.pdf

[30] Kampshoff, P., Kumar, A., Peloquin, S. , Sahdev, S. Building the electric-vehicle charging infrastructure America needs. April 18, 2022. https://www.mckinsey.com/industries/public-and-social-sector/our-insights/building-the-electric-vehicle-charging-infrastructure-america-needs

[31] Levinson, RS and West TH. Impact of convenient away-from-home charging infrastructure. Transportation Research Part D: Transportation and Environment. 65 (December 2018): 288-299. https://doi.org/10.1016/j.trd.2018.09.006

[32] U.S. Environmental Protection Agency. Population and Activity of On-road Vehicles in MOVES2014. EPA-420-R-16-003. January 2016. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100O7VJ.pdf

[33] Zhu, P., and S. G. Mason. "The Impact of Telecommuting on Personal Vehicle Usage and Environmental Sustainability." International Journal of Environmental Science and Technology 11, no. 8 (November 2014): 2185–2200. https://doi.org/10.1007/s13762-014-0556-5.

Appendix A: Strategy and Action Summary

Climate and Equity Focused Governance Strategies

Strategy G-1: Establish a Climate Action Subcabinet

Strategy G-2: Prioritize Climate Action in all Aspects of Planning and Operations

Strategy G-3: Integrate Equity and Inclusivity into All Climate Action and Prioritize Communities Most Vulnerable to the Impacts of Climate Change

Strategy G-4: Communicate Climate Action Progress Regularly and Transparently and Create Outreach That Engages the Community in Accomplishing Goals

Strategy G-5: Leverage State and Federal Programs and Funding Sources Whenever Possible to Advance Climate Action

Mitigation Strategies: Energy

Strategy E1: Reduce Greenhouse Gas Emissions from Existing Buildings

- Action 1: Increase energy efficiency and conservation in all existing residential, commercial and government buildings
- Action 2: Increase electrification in existing residential, commercial and government buildings
- Action 3: Accelerate the adoption of low GWP refrigeration and air conditioning equipment in commercial properties and reduce refrigerant leaks

Strategy E2: Construct Efficient and Low-Carbon Buildings

- Action 1: Implement more stringent green building standards for new residential, commercial, and government properties
- Action 2: Phase-in requirements for all-electric new construction for residential, commercial and government properties

Strategy E3: Decarbonize the Energy Supply

- Action 1: Expand the development of solar energy for residential, commercial, and government properties

Mitigation Strategies: Transportation

Strategy T1: Maximize the Use of Electric Vehicles

- Action 1: Continue to develop a robust EV charging station infrastructure
- Action 2: Accelerate the adoption of electric vehicles in the community and County government fleet
- Action 3: Transition to a zero-emissions transit vehicle fleet
- Action 4: Transition to a zero-emissions school bus fleet

Strategy T2: Reduce Vehicle Miles Traveled in Single Occupancy Vehicles

- Action 1: Increase public transit ridership by enhancing the effectiveness and reliability of local and regional public transit
- Action 2: Implement microtransit in less dense areas that have a demonstrated need of connection between homes, jobs, and services
- Action 3: Expand and improve sidewalks, crosswalks, pathways and bike lanes and connect them to jobs, shopping, schools, and recreational amenities
- Action 4: Increase and normalize teleworking options for employees whenever possible
- Action 5: Implement policies, outreach programs, and incentives to promote individual behavior changes to reduce emissions from personal vehicles

Mitigation Strategies: Waste

Strategy W1: Reduce Organic Waste Sent to Landfills and Manage Landfill Methane

- Action 1: Reduce organic waste and expand composting in the residential sector
- Action 2: Incentivize businesses and schools to reduce organic waste and participate in composting
- Action 3: Ensure that Howard County's Alpha Ridge Landfill and closed landfills meet or exceed the state and federal methane requirements.

Strategy W2: Expand the Use of Sustainable Materials and Reduce Waste Generation and Disposal

- Action 1: Improve sustainable procurement in government operations
- Action 2: Reduce the use of single-use items, particularly plastics and promote waste reduction and reuse throughout Howard County

Mitigation Strategies: Nature-Based

Strategy N1: Support Nature Based Climate Solutions to Improve Soil Health, Increase Carbon Sequestration, and Reduce Emissions

- Action 1: Incentivize adoption of Natural Resources Conservation Service (NRCS) conservation practices that reduce GHG's and sequester carbon
- Action 2: Improve soil health on private lands through outreach and program expansion
- Action 3: Increase sustainable landscaping practices on public lands to improve soil health and reduce GHG emissions

Strategy N2: Conserve Existing Forests and Expand the Tree Canopy

- Action 1: Protect and restore forest and non-forest tree canopy

Resiliency Strategies

Strategy R-1: Become a model for excellent communication, education, and outreach about climate hazards, emergency preparedness, and available resources

- Action 1A: Create a one stop shop for all resources and services relating to climate hazards
- Action 1B: Improve existing communication, education, and outreach methods and research best practices to reach communities
- Action 1C: Ensure equitable access to information
- Action 1D: Maximize outreach opportunities by layering emergency preparedness information into County communication tools

Strategy R-2: Improve emergency preparedness of Howard County citizens

- Action 2A: Increase number of individual citizens with emergency kits and emergency plans
- Action 2B: Increase capacity of organizations that can provide emergency services before and during an emergency
- Action 2C: Target more education and outreach efforts about emergency preparedness and climate action to communities most vulnerable to heat and flooding impacts

Strategy R-3: Improve access to emergency shelters, cooling centers, and resources during climate hazard events, especially for underserved and under-resourced communities

- Action 3A: Raise awareness of and add new warming/cooling centers, emergency shelters, and comfort centers as needed, prioritizing underserved areas
- Action 3B: Maximize transportation options to get to and from emergency centers during climate hazard emergencies

Strategy R-4: Increase resiliency of buildings, infrastructure and communities to match anticipated climate hazards

- Action 4A: Continue to lead nationally on building safety and resiliency by researching and piloting building code updates to increase resiliency to severe storms, flooding and heat beyond life safety
- Action 4B: Promote existing programs to protect underserved populations from extreme heat and explore opportunities to expand eligibility for these programs to more people
- Action 4C: Promote and incentivize building best practices that protect people from impacts of extreme heat
- Action 4D: Improve resilience of critical infrastructure to flooding, heat and other climate hazards
- Action 4E: Implement microgrids throughout Howard County where feasible, prioritizing areas that meet critical community needs
- Action 4F: Implement resiliency hubs to meet critical emergency needs for the community
- Action 4G: Expand recruitment and training for technicians to support HVAC, microgrids, and emergency generators

Strategy R-5: Reduce heat islands and increase shade in heat vulnerable areas

- Action 5A: Research and map heat vulnerable areas with a focus on underserved populations
- Action 5B: Strategically increase tree planting in heat vulnerable areas on both public and private land

- Action 5C: Research and incorporate use of shade structures and cool surface technologies in public amenities and spaces

Strategy R-6: Increase installation and facilitate maintenance of stormwater best management practices on residential, commercial, and non-profit properties

- Action 6A: Expand the CleanScapes program to increase installation and maintenance of stormwater practices on residential properties, with a focus on areas of high flood risk as well as underserved communities
- Action 6B: Enhance the Community Stormwater Partnership Grant program to further support stormwater best management practices in flood-prone areas, vulnerable watersheds, and underserved communities
- Action 6C: Expand Commercial Stormwater Solutions Program to provide flexibility in program structure and account for the financial impacts of BMP installation and retrofits to property owners
- Action 6D: Provide BMP maintenance support and resources that ensure long term success of BMPs installed as part of new development
- Action 6E: Leverage existing Nonprofit Watershed Protection Partners to implement stormwater management and outreach

Strategy R-7: Prioritize stormwater management by strengthening regulations, policies, and innovation

- Action 7A: Develop a Howard County specific stormwater management guide
- Action 7B: Consider adjusting and strengthening stormwater management regulations based on climate change predictions
- Action 7C: Increase support for maintenance and infrastructure updates
- Action 7D: Employ innovation and natural solutions in stormwater management
- Action 7E: Establish a fund for pilot projects to encourage innovation
- Action 7F: Explore increasing the Watershed Protection and Restoration Fee, as well as alternative funding solutions
- Action 7G: Improve reclaimed water capacity and usage

Strategy R-8: Determine vulnerable watersheds and prioritize recommended stormwater solutions

- Action 8A: Establish a new program designed to aid Vulnerable Watersheds

Strategy R-9: Maximize the resiliency benefits derived from ecosystem services by improving protections for wetlands, forests, and streams and increasing the acreage of these resources through restoration or creation

- Action 9A: Improve the protection of existing wetlands, restore degraded wetlands, and investigate wetland creation opportunities
- Action 9B: Improve the protection of existing forests, restore degraded forests, and increase forest acreage where possible. Retain and expand non-forest tree canopy
- Action 9C: Improve the protection of streams, restore degraded streams, and increase stream buffers where possible
- Action 9D: Protect and enhance the natural resources in the Green Infrastructure Network
- Action 9E: Ensure that planting practices evolve to be resilient to climate change

Appendix B: Glossary

100-year Flood: A flood or storm that has a 1% probability of occurring in any given year. The 100year flood zone is the extent of the area of a flood that has a 1% chance of occurring or being exceeded in a given year.

500-year Flood: A flood or storm that has a 0.2% probability of occurring in any given year. The 500year flood zone is the extent of the area of a flood that has a 0.2% chance of occurring or being exceeded in a given year.

Action: A specific activity that supports achieving a broader strategy.

Adaptation: Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects. Adaptation can lead to greater resilience.

Alley Cropping: An agroforestry practice that places trees within agricultural cropland systems.

Baltimore Metropolitan Council (BMC): A nonprofit organization that works collaboratively with the chief elected officials in the region to create initiatives to improve our quality of life and economic vitality. The BMC region includes Anne Arundel County, Baltimore City, Baltimore County, Carroll County, Harford County, Howard County, and Queen Anne's County.

Benchmarking: 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.

Best Management Practices (BMPs): Effective methods used to treat, prevent, or reduce water pollution.

Biodiesel: A renewable, biodegradable fuel manufactured domestically from vegetable oils, animal fats, or recycled restaurant grease.

Bioretention: A soil bed planted with suitable non-invasive (preferably native) vegetation. Stormwater runoff entering the bioretention system is filtered through the soil planting bed before being either conveyed downstream by an underdrain system or infiltrated into the existing subsoil below the soil bed.

Building Envelope: Includes the walls, windows, roof, and foundation, forms the primary thermal barrier between the interior and exterior environments.

Built Environment: The man-made or modified structures that provide people with living, working, and recreational spaces.

Carbon Dioxide: An important heat-trapping gas, or greenhouse gas, that comes from the extraction and burning of fossil fuels (such as coal, oil, and natural gas), from wildfires, and from natural processes like volcanic eruptions.

Carbon Dioxide Equivalent: A metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

Carbon Sequestration: The process of capturing and storing carbon dioxide from the atmosphere through soils, trees, and other systems.

Carbon Storage: The building of plant structures (biomass) by converting glucose into cellulose and lignin. Most carbon in a forest is stored in the soil and the above-ground living biomass (e.g., trees and other plants).

Census Tract: Small, relatively permanent statistical subdivisions of a county as determined by the U.S. Census Bureau.

Chemical Fertilizer: Any inorganic material of wholly or partially synthetic origin that is added to soil to sustain plant growth.

Climate Change: Any change in climate over time, whether due to natural variability or as a result of human activity. Climate refers to long-term trends in weather over decades.

Climate Impact: A consequence of climate change, usually expressed as consequences on human health and well-being, the local economy, general quality-of-life, or similar terms.

Climate Vulnerability: Climate vulnerability describes the degree to which natural, built, and human systems are at risk of exposure to climate change impacts.

Commercial Property Assessed Clean Energy (C-PACE): A type of clean energy loan program that uses borrowed capital to pay for the upfront costs associated with energy efficiency or renewable energy improvements. Unlike other project financing, the borrowed capital is repaid over time via a property tax assessment. This allows the repayments of the loan to be transferred to a new owner if the property is sold.

Community Solar: Local solar facilities shared by multiple community subscribers such as individuals, businesses, nonprofits, and other groups, who receive credit on their electricity bills for their share of the power produced. This model helps solar developers secure financing for projects and allows community subscribers to benefit from the solar project with costs savings similar to those they would experience from installing solar on their own property.

Composting: A controlled, aerobic (oxygen-required) process that converts organic materials into a nutrient-rich soil amendment or mulch through natural decomposition. The end product is compost – a dark, crumbly, earthy-smelling material that is used to amend soil and provide nutrients for plant growth.

Critical Facility: Those structures from which essential services and functions for public safety and disaster recovery are performed or provided.

Decarbonization: The process of replacing fossil fuels with fuel that is less harmful to the environment.

Derechos: A long band of windstorms that stretch across a large area of land with winds similar in strength as a tornado or hurricanes. These storms produce heavy winds, thunderstorms, and rain.

Electrical Grid: A network of transmission lines, substations, transformers and more that deliver electricity from the power plant to homes, businesses and other electricity users.

Electric Vehicle: A vehicle that can be powered by an electric motor that draws electricity from a battery and is capable of being charged from an external source. An EV includes both a vehicle that can only be powered by an electric motor that draws electricity from a battery (all-electric vehicle) and a vehicle that can be powered by an electric motor that

draws electricity from a battery and by an internal combustion engine (plug-in hybrid electric vehicle). The use of EV in Howard County Climate Forward refers to all-electric vehicles unless otherwise stated.

Electrification: The process of replacing building systems and appliances that burn fossil fuels such as oil and gas onsite with building systems and appliances that use electricity to reduce overall greenhouse gas emissions.

Emergency Kit: A kit that has all of the things an individual or family may need during an emergency in which people may have to stay inside for longer than usual or the electricity could go out.

Energy Audit: An assessment that can help determine how much energy a building uses, where the building is inefficient, and which problem areas and fixes to prioritize to save energy and improve the comfort of your building.

Energy Efficiency: The use of less energy to perform the same task or produce the same result. Energy-efficient homes and buildings use less energy to heat, cool, and run appliances and electronics, and energy-efficient manufacturing facilities use less energy to produce goods.

Energy STAR: A joint program of the Environmental Protection Agency (EPA) and the Department of Energy (DOE). Its goal is to help consumers, businesses, and industry save money and protect the environment through the adoption of energy-efficient products and practices. The ENERGY STAR label identifies top-performing, cost-effective products, homes, and buildings.

Equity: The act of fairness and justice, creating equal outcomes by allocating resources and opportunities to meet individual needs of specific communities.

Extreme Weather: A weather event that is rare at a particular place and time of year or is more intense or severe than is typically experienced in that location, including heatwaves, cold waves, heavy rains, periods of drought and flooding, and severe storms.

Fuel Cell: Technology that uses the chemical energy of hydrogen or other fuels to cleanly and efficiently produce electricity.

Fugitive Emissions: The unintentional and undesirable emission, leakage, or discharge of gases or vapors from pressure-containing equipment or facilities, and from components inside an industrial plan such as valves, piping flanges, pumps, storage tanks, compressors, etc. These emissions also may include leaks from transmission pipes.

Fluorinated Gas (F-gas): Gases that have no significant natural sources and come almost entirely from human-related activities. They are emitted through their use as substitutes for ozone-depleting substances (e.g., as refrigerants) and through a variety of industrial processes such as aluminum and semiconductor manufacturing. Many fluorinated gases have very high global warming potentials (GWPs) relative to other greenhouse gases, so small atmospheric concentrations can have disproportionately large effects on global temperatures.

Forest Fragmentation: A loss of forest and the division of the remaining forest into smaller blocks.

Generator: A machine by which mechanical energy is changed into electrical energy. Generators often are used to provide a backup source of power for an individual house or building during electrical grid outages and are typically fueled with diesel, gasoline, natural gas, propane, or other fossil fuels.

Geothermal Energy: Heat energy from the earth. Wells, ranging from a few feet to several miles deep, can be drilled into underground reservoirs to tap steam and very hot water that can be brought to the surface for use in a variety of applications, including electricity generation, direct use, and heating and cooling. Geothermal also can use the steady ground temperature of about 55°F to heat or cool water that is then circulated through buildings to provide energy efficient heating or air conditioning.

Global Warming Potential (GWP): A measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO2).

Governance: All processes of governing, the institutions, processes and practices through which issues of common concern are decided upon and regulated.

Graywater: Used water that contains low levels of containments from household, commercial, or industrial activities such as showering, bathing, doing laundry, doing dishes etc.

Greenhouse Gas: Gases that trap heat in the atmosphere.

Greenhouse Gas Inventory: A list of greenhouse gas emission sources and the associated emissions quantified using standardized methods.

Hazard: The occurrence of a natural event or trend that can have impacts on human health and infrastructure; for example: heat, precipitation, flooding, extreme storms.

Heat Index: What the temperature feels like to the human body when relative humidity is combined with the air temperature.

Heat Island: An area where temperatures are higher than surrounding areas due to impervious heat-absorbing surfaces such as asphalt and concrete.

Heat Pump: An energy-efficient alternative to furnaces and air conditioners that uses electricity to transfer heat from a cool space to a warm space, making the cool space cooler and the warm space warmer.

Heatwave: A prolonged period of abnormally hot weather.

Hydroflourocarbons (HFCs): Greenhouse gases (GHGs) commonly used in a wide variety of applications, including refrigeration, air-conditioning (AC), building insulation, fire extinguishing systems, and aerosols. HFCs have high global warming potential (GWP), raising concern about their impacts as they become increasingly used as replacements for ozone-depleting substances (ODS), and as economic growth spurs demand for new equipment, especially in the refrigeration/AC sector.

ICLEI's ClearPath Tool: An online software platform for completing greenhouse gas inventories, forecasts, climate action plans, and monitoring at the community-wide or government-operations scales.

Impervious Surface: All hard surfaces like paved roads, parking lots, roofs, and even highly compacted soils like sports fields. Rain and other precipitation cannot penetrate and soak down into these surfaces and instead runs off these surfaces, picking up heat and pollutants, and running off into storm drains and streams.

Induction Stove: Induction cooking tops consist of an electromagnetic coil that creates a magnetic field when supplied with an electric current. When brought into this field, compatible cookware is warmed internally, transferring energy with approximately 85% efficiency. These stovetops run on electricity, not on natural gas.

Infrastructure: The basic systems and services that are necessary for a country or an organization to run smoothly, for example buildings, transport and water and power supplies.

Intergovernmental Panel on Climate Change (IPCC): The United Nations body for assessing the science related to climate change.

International Green Construction Code (IGCC): A model building code that provides minimum requirements to safeguard the environment, public health, safety and general welfare through the establishment of requirements that are intended to reduce the negative impacts and increase the positive impacts of the built environment on the natural environment and building occupants.

Invasive Species: An organism that causes ecological or economic harm in a new environment where it is not native.

Leadership in Energy and Environmental Design (LEED): The most widely used green building rating system in the world. Available for virtually all building types, LEED provides a framework for healthy, efficient, and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement and leadership.

LEDs: Light emitting diode, a highly energy-efficient lighting technology

Life-Cycle Analysis: A comprehensive form of analysis that utilizes the principles of Life Cycle Assessment, Life Cycle Cost Analysis, and various other methods to evaluate the environmental, economic, and social attributes of energy systems ranging from the extraction of raw materials from the ground to the use of the energy carrier to perform work.

Life-Cycle Costing: Considering all the costs that will be incurred during the lifetime of a product, work or service: Purchase price and all associated costs (delivery, installation, insurance, etc.) Operating costs, including energy, fuel and water use, maintenance and end-of-life disposal.

Methane: An odorless, colorless, flammable greenhouse gas emitted from energy, industry, agriculture, land use, and waste management activities. Methane has been determined to have a global warming potential of 27 to 30 times that of carbon dioxide.

Microgrid: An on-site power generation system for one or more buildings that can tie to the utility grid but also can operate independently of the grid during power outages including major outages of long duration.

Micromobility: Any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances.

Microtransit: Flexible, on-demand transit system that is conceptually in between private individual transportation and public mass transit. For example, microtransit may use vans or other small, multi-passenger vehicles to provide shared, on-demand transit that is more flexible than the typical public transit model of fixed routes and timetables.

Mitigation: Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere.

Native Plant: The indigenous species that have evolved and occur naturally in a particular region, ecosystem, and habitat. Species native to North America are generally recognized as those occurring on the continent prior to European settlement.

Natural Gas: An odorless, gaseous mixture of hydrocarbons—predominantly made up of methane (CH_4).

Nature-Based: Actions to protect, sustainably manage, or restore natural ecosystems, that address societal challenges such as climate change, human health, food and water security, and disaster risk reduction effectively and adaptively, providing human well-being and biodiversity benefits.

Net Zero: Reducing amount of greenhouse gas emissions to zero, or close to zero, by balancing the amount released into the atmosphere with the amount removed from the atmosphere.

Organic Waste: All waste of biological origin (which was once alive or part of a living thing).

Paratransit: "Origin to destination" services for people with disabilities who are not able to ride fixed-route public transportation.

Pesticide: A substance that kills, repels, or controls forms of animal and plant life considered to damage or be a nuisance in agriculture and domestic life.

Polar Vortex: A large area of low pressure and cold air surrounding both of the Earth's poles. It ALWAYS exists near the poles, but weakens in summer and strengthens in winter. The term "vortex" refers to the counter-clockwise flow of air that helps keep the colder air near the Poles. Many times during winter in the northern hemisphere, the polar vortex will expand, sending cold air southward with the jet stream.

Pollinator: Anything that helps carry pollen from the male part of the flower (stamen) to the female part of the same or another flower (stigma). Typical pollinators include bees, butterflies, and some species of birds.

Pollution: The presence of substances and heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects; activity that generates pollutants.

Rain Garden: A low lying area created to absorb and filter runoff from roofs, driveways and parking lots. Rain gardens are generally planted with native plants adapted for high levels of water, which help to hold the runoff and filter pollutants while the runoff water slowly soaks into the ground.

Rebate: A return of a part of a payment.

Reclaimed Water: Wastewater from a municipal sewage treatment facility that has been treated to be suitable for beneficial use.

Refrigerant: A chemical that produces a cooling effect while expanding or vaporizing. Refrigerants are typically used in refrigeration and air conditioning.

Renewable Energy: Energy produced from sources like the sun and wind that are naturally replenished and do not run out.

Resilience: 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.

Retrocommissioning: A building systems tune-up that applies the commissioning process to a building that has been commissioned previously (either during construction or as an existing building); it is normally done every three to five years to maintain top levels of building performance and/or after other stages of the upgrade process to identify new opportunities for improvement. Retrocommissioning is a low cost measure that can result in big energy savings in buildings.

Retrofit: Involves the modifications to existing buildings that may improve energy efficiency or decrease energy demand.

Riparian Buffer: An area adjacent to a stream, lake, or wetland that contains a combination of trees, shrubs, and/or other perennial plants and is managed differently from the surrounding landscape, primarily to provide conservation benefits.

Silvopasture: The deliberate integration of trees and grazing livestock operations on the same land. These systems are intensively managed for both forest products and forage, providing both short- and long-term income sources.

Single-use Plastic: Items intended to be used only once before they are thrown away or recycled. These include, among other items, grocery bags, food packaging, bottles, straws, containers, cups and cutlery.

Solar Power: Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage.

Stakeholder: One who is involved in or affected by a course of action.

Stationary Fuel Combustion: Devices that combust solid, liquid, or gaseous fuel, generally for the purposes of producing electricity, generating steam, or providing useful heat or energy for industrial, commercial, or institutional use, or reducing the volume of waste by removing combustible matter. Stationary fuel combustion sources include, but are not limited to, boilers, simple and combined-cycle combustion turbines, engines, incinerators, and process heaters.

Stormwater: Falling precipitation that can't be absorbed by pervious surfaces or runs off impervious surfaces and enters water ways, picking up pollutants along the way.

Strategy: An overarching policy or approach designed to achieve a specific climate goal, like reducing greenhouse gas emissions or increasing County resilience. Strategies often are comprised of one or more actions.

Sustainability: To create and maintain conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations.

Tree Canopy: The layer of leaves, branches and stems of trees that shelter the ground when viewed from above. This measurement is expressed as a percentage of ground area that is covered by tree crowns and relates to the branching spread of the trees.

Under-Resourced Population: Populations that lack adequate access to community resources. These populations tend to be economically disadvantaged and may also include people who are disabled, people whose primary language is not English, people of color, and people ages 65 and over.

Underserved Population: Populations that face health, financial, educational, and/or housing disparities. These populations tend to receive fewer health care services, encounter barriers to services such as economic, cultural or linguistic barriers, or have a lack of familiarity with available services.

Vulnerable Population Index: The data and the analyses undertaken to identify a region's vulnerable people and groups. The index developed by the Baltimore Metropolitan Council includes maps showing concentrations of groups that have low income, limited English proficiency, disabilities, no car, and/or are elderly.

Waste to Energy: The conversion of non-recyclable waste materials into usable heat, electricity, or fuel through a variety of processes, including combustion, gasification, anaerobic digestion and landfill gas recovery.

Watershed: A land area that drains rainfall and snowmelt into a specific waterbody, which could include a creek, stream, river, bay, lake, or ocean. Every body of water has a watershed. Activities on the land within a watershed can impact water quality and quantity of the water body into which it drains.

Weatherization: The act of protecting a structure, such as a house or building, from the elements of weather by installing energy efficient measures such as air sealing, insulation, moisture control, ventilation, heating and air conditioning. Weatherization often starts with an energy audit to determine energy uses and potential energy saving opportunities in a building. Weatherization assistance is available to low-income households and can result in greater comfort and in lower utility bills.

Wet bulb temperature: This is a way to measure the combination of dry air temperature and humidity. A wet cloth over the bulb of a thermometer cools the temperature, but if the humidity in the air is high, less evaporation occurs so the wet-bulb temperature is closer to the dry air temperature. The wet-bulb temperature measures how well humans will be able to cool themselves through sweating.

Wetland: Areas where water covers the soil or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Some types of wetlands include marshes, bogs and swamps.

Windbreaks: Linear plantings of trees and shrubs designed to provide economic, environmental and community benefits. The primary purpose of most windbreaks is to slow the wind which creates a more beneficial condition for soils, crops, livestock, wildlife and people.

Appendix C: Climate Vulnerability Assessment Methodology

Methodology

Howard County conducted a preliminary Climate Vulnerability Assessment to assess its vulnerability to climate change. Howard County used ICLEI's Temperate tool and Climate Vulnerability Assessment framework to assess a variety of potential hazards and the risks they pose to natural resources, economic systems, human health, and infrastructure within the county.

The Temperate tool, designed by Azavea Inc. and ICLEI – Local Governments for Sustainability, is an adaptation planning application that helps counties identify their risks to hazards. The tool recommends a list of potential hazards that are likely to worsen due to the changing climate using historical data and future projection trends of hazards in the area.

The Temperate tool uses findings from the 2014 National Climate Assessment to identify potential future climate hazards that are specific to Howard County. The tool also uses climate change indicator data under two emission scenarios from both NASA Earth Exchange Global Daily Downscaled Projections (NASA NEX-GDDP) and Localized Constructed Analogs (LOCA) datasets.

Using Temperate data, Howard County's Hazard Identification Risk Assessment, and subject matter expert assessments, Howard County's Office of Community Sustainability (OCS) identified eight hazards that are applicable to Howard County. The hazards evaluated are Air-Borne Disease, Hurricanes, Drought, Extreme Heat Days, Extreme Winter Conditions, Flooding, Severe Wind, and Vector-borne disease. OCS then evaluated the risks these hazards could pose to nine community systems: Agriculture, Ecological Function, Emergency Management, Energy Delivery, Internet and Communications, Public Health, Public Safety, Quality of Life, Tourism, Highways/Transportation, Stormwater, and Utilities.

Howard County's Temperate findings and the Baltimore Metropolitan Council (BMC) report indicates a moderate- high risk probability, and increasing frequency and intensity, for flash and surface flooding. They also report extreme heat to be a moderate- to high-risk probability and increasing frequency and intensity of extreme hot days with moderate to high impacts across community systems.

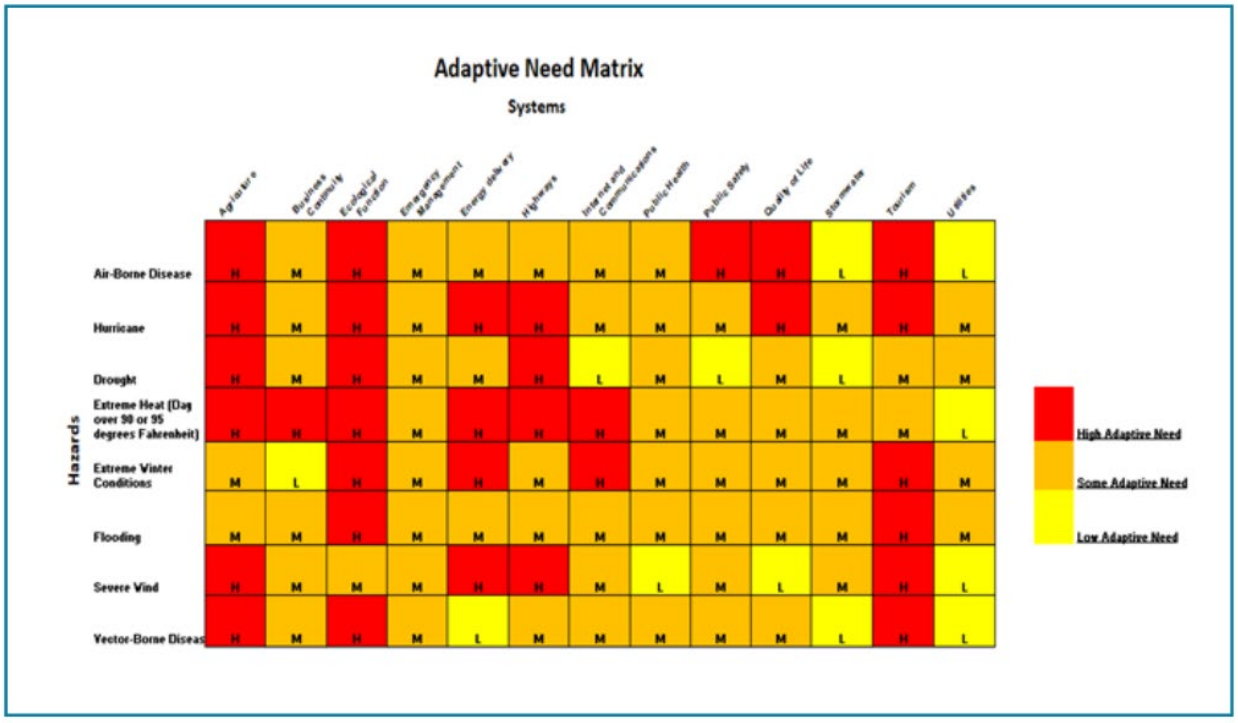
Subject Matter Experts across several county departments and agencies helped OCS evaluate the vulnerability of each system to each climate hazard. Through a survey, Subject Matter Experts ranked both the potential impact on the system from each hazard and the community's adaptive capacity to react to and rebound from the hazard. Subject Matter Experts also had the option to further describe impacts the hazards would have on their operations and the community. This information was entered into the Temperate tool, which calculated an adaptive need score based on the average values of the impact magnitude and the adaptive capacity score selected by Subject Matter Experts. The adaptive need score is illustrated using a color scale, ranging from yellow to red. Yellow represents a low adaptive need score, red represents a high adaptive need score, and orange represents some adaptive need A low adaptive need score is the combination of a low impact ranking and a high adaptive capacity ranking, while a high adaptive need score is the combination of a high impact ranking and low adaptive capacity ranking. Systems with a higher adaptive need score, represented by the color red, tells us that these systems have a higher vulnerability to hazards and will need to be made more resilient by the County.

Subject Matter Experts include representatives from the Office of Community Sustainability, Department of Health, Department of Public Works – Highways, Environmental Services, and Utilities, Department of Police, Howard County Tourism, Inc., Howard County Economic Development Authority, Department of Fire and Rescue, Department of Technology and Community Services, and BGE. Additional expertise was provided by Dr. Sara Via who is a Climate Expert with the University of Maryland Cooperative Extension.

Results

Extreme Heat and Flooding were identified as the top two hazards for Howard County. Extreme Heat has a moderate- to high-risk probability and moderate to high impacts on agriculture, business continuity, ecological function, energy delivery, highways and internet and communications. Flooding has a moderate- to high-risk probability and moderate impacts on systems. While the County has some adaptive capacity to deal with the impacts of flooding, the BMC report shows that inland flooding will have significant impacts on transportation, stormwater, wastewater, facilities and solid waste service areas. Howard County's Temperate results show that flooding will have high impacts on tourism and ecological function. The combination of high-risk probabilities increasing frequency and intensity of these hazards and the impacts of hazards on systems is how these hazards were chosen.

The table below lists the potential impacts of extreme heat, flooding/increased precipitation, extreme weather (hurricanes, severe wind, storms), and other (air-borne disease, vector-borne disease, extreme winter conditions, and drought) on community systems and ability of community systems to mitigate or adapt to the potential future impacts.



CVA Methodology (Adaptive Need Matrix) Figure 1.

Appendix D: Climate Change Emergency Preparedness Survey

Background

Howard County Government's Climate Change Emergency Preparedness Survey was designed to understand how residents are being impacted by climate change now and how prepared residents are for climate hazards. It also helped identify barriers to information and access to emergency preparedness resources experienced by underserved communities. The survey was administered by Howard County's Office of Community Sustainability and conducted in June 2022 as part of the County's Climate Action Plan update. The survey includes questions about preparedness for various climate hazards and the impacts of these hazards. The climate hazards were chosen based on Howard County's Climate Vulnerability Assessment, nearby jurisdictions' Climate Vulnerability Assessments, and regional climate data. Vector-borne disease, airborne disease, extreme heat, extreme winter conditions, flooding, poor air-quality, drought, flooding, hurricanes, and severe wind are expected to increase in frequency and/or intensity in the region and have the potential to cause disruption to daily life.

This primary target audience of the survey was Howard County residents who are part of underserved communities. The County defined underserved communities as people of color, people ages 65 and older, people with disabilities, people with low-income, and people with limited English language ability. According to a recent Environmental Protection Agency report titled *Climate Change and Social Vulnerability in the United States,* underserved communities are disproportionately vulnerable to the impacts of climate change. These groups may not have the same ability as other groups to prepare for, adapt to, and recover from the impacts of climate change due to a combination of social, economic, political, and environmental factors. Systemic inequities and an unequal distribution of wealth and resources cause barriers for these groups.

Questionnaire Design

The survey consisted of 27 questions including multiple choice and free form responses. The survey was divided into four sections: Health and Well-Being, Emergency Preparedness, Emergency Preparedness Awareness and Knowledge, and Demographics.

The Health and Well-Being section included three questions that asked residents about their concerns and experiences with climate-related hazards. This section asked for residents to reflect on how the selected climate hazards have affected their day-to-day functions. The responses were used to understand what residents most are concerned about and what they have already experienced.

The Emergency Preparedness section was composed of twelve questions that asked residents about preparation, services and resources, and disabilities that may impact one's ability to access emergency services and resources.

The Emergency Preparedness Awareness and Knowledge section consisted of seven questions on how residents feel about various statements, and what residents would like to learn more about.

The Demographics section collected information about gender, age, race, ethnicity, and total household income. This section allowed the County to get a better understanding of the representative population of survey respondents. By analyzing the data and using cross-tabulation, the County has the potential to spot trends in responses by groups. The data collected from the surveys will be used to improve climate action, resiliency, and adaptation in the community.

Survey Distribution Method

To reach these populations, staff asked organizations that provide services and resources to our target groups to distribute surveys through email lists and newsletters. Newsletters contained a link that directed respondents to the survey page on the LiveGreenHoward website. In coordination with the Howard County Health Department, staff distributed printed fliers with QR codes that directed respondents to the survey at clinics and other health-related events including Glen Mar Church Community Health Fair, Owen Brown Clinic, and the Health Department's Family Wellness Event. Fliers also were distributed to multiple service centers such as the Columbia Food Bank, Hopeworks, Community Action Council, Dancel YMCA, the County's Multiservice Center, and various 50+ centers, community centers, and libraries. While most of the respondents chose to fill the survey out online, there were options for the respondents to fill out the survey over the phone or on paper.

In addition, the County contracted with the Clean Water Fund to send canvassers door-to-door to several communities to distribute surveys directly to residents or to leave doorhangers with survey information on resident's doors. The locations canvassed by Clean Water Fund were Columbia Landing, Columbia Commons, Monarch Mills, and houses off Tamar Drive in Columbia, MD. The locations were strategically chosen by County staff using EJ Screen's demographic indicators to identify communities of the target populations.

Results

- Airborne Disease, Poor Air Quality, and Extreme Heat are the top three hazards that Howard County survey respondents are most concerned about.
- Power outages and damage to home or property after a storm are the two most common experiences faced in the last two years.
- Survey respondents identified flooding, hurricanes, and drought as hazards that they are least prepared for.
- The majority of survey respondents (83%) do not know where a heating/cooling center is, and the majority of survey respondents (81%) would use a heating/cooling center if needed. The most common reason for not using a heating/cooling center is because the respondent did not know there was an option to go to a heating/cooling center.
- The majority of respondents aged 65 or older (85%) would use a cooling center if needed. 65+ respondents who wouldn't use a heating/cooling center listed not knowing heating/cooling centers were an option and not having access to transportation as reasons they would not use one.
- Approximately 75% of respondents do not know where to get food/water in an emergency event.
- More than 75% of respondents feel they know about the impacts of climate change.
- Nearly a quarter of respondents do not feel prepared if an emergency event were to occur.
- Nearly 50% of respondents feel generally that the community has resources and services to help them during an emergency event.
- 38% of respondents feel they do not know how to easily access community resources and services. There is a difference in responses from individuals of an underserved community versus responses from individuals not of an underserved community. 34% of those respondents not underserved feel they cannot easily access community resources and services, whereas 40% of underserved respondents feel they cannot easily access community resources and services.
- Approximately 75% of survey respondents feel the community keeps them informed about severe weather.
- Nearly 70% of respondents are interested in learning more about disaster preparedness.

Appendix E: Greenhouse Gas Emissions Inventory

As part of its 2023 Climate Action Plan, Howard County developed a County-wide greenhouse gas (GHG) emissions inventory to identify and quantify private and public sector sources and drivers of emissions. To develop this inventory, Howard County used 2019 data, the most recent and most complete set of data available for all sectors at the time this Climate Action Plan was developed. Howard County used the ClearPath emissions management software suite from ICLEI-USA as a basis for the County-wide 2019 GHG inventory. ClearPath was developed by ICLEI to help local governments inventory community and government GHG emissions. Users can input activity data where available or use default settings provided by ClearPath to reach a rough estimation of GHG emissions within the community or local government operations.

The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, developed by ICLEI, establishes requirements for creating community and government operation inventories of GHG emissions. This protocol focuses on calculating emissions based on the activity from which they originate. At a minimum, inclusion of five basic emissions generating activities is required in all protocol-compliant GHG inventory reports. These activities were selected by ICLEI because they represent activities over which local governments typically have significant control, data to estimate emissions are reasonably available, emissions associated with the activity are significant, and the activities are common.[1] These five categories, at a high level, include:

- Use of electricity by the community.
- Use of fuel in residential and commercial stationary combustion equipment.
- On-road passenger and freight motor vehicle travel.
- Use of energy in potable water and wastewater treatment and distribution.[2]
- Generation of solid waste by the community.

GHG emissions are commonly grouped into three categories, or scopes. Scope 1 emissions are direct emissions generated locally, including on-site energy combustion like natural gas or other fuels, refrigerants, and vehicle emissions. Scope 2 emissions are indirect emissions from purchased energy, typically electricity. This includes the GHG emissions from energy generated off-site but purchased and used on-site for activities such as powering home and commercial buildings. Scope 3 emissions are indirect emissions generated outside of the County from the production of goods or services used in-County. This includes off-site emissions from the production, transportation, distribution, and disposal of products used on-site. Scope 3 emissions are much more difficult to measure and typically are not included in a local government GHG inventory.

The Howard County GHG inventory includes primarily scope 1 and 2 emissions. Howard County's scope 1 emissions include on-site fuel combustion, transportation, waste generated and landfilled in Howard County, refrigerant emissions, fugitive emissions (emissions from leaks in oil and gas pipelines), and soil nitrogen dioxide emissions from agricultural activities. Howard County's scope 2 emissions include all purchased electricity used by residents, businesses, and government within the County. Howard County also felt it was important to include scope 3 emissions specifically from waste generated in Howard County but landfilled outside of Howard County, as most waste is transported out of County for disposal.

Howard County's 2019 GHG inventory includes sources in the built environment; transportation and other mobile sources; solid waste; and wastewater and water sectors. These emissions are documented at the community level and include any emissions generated from County government operations.

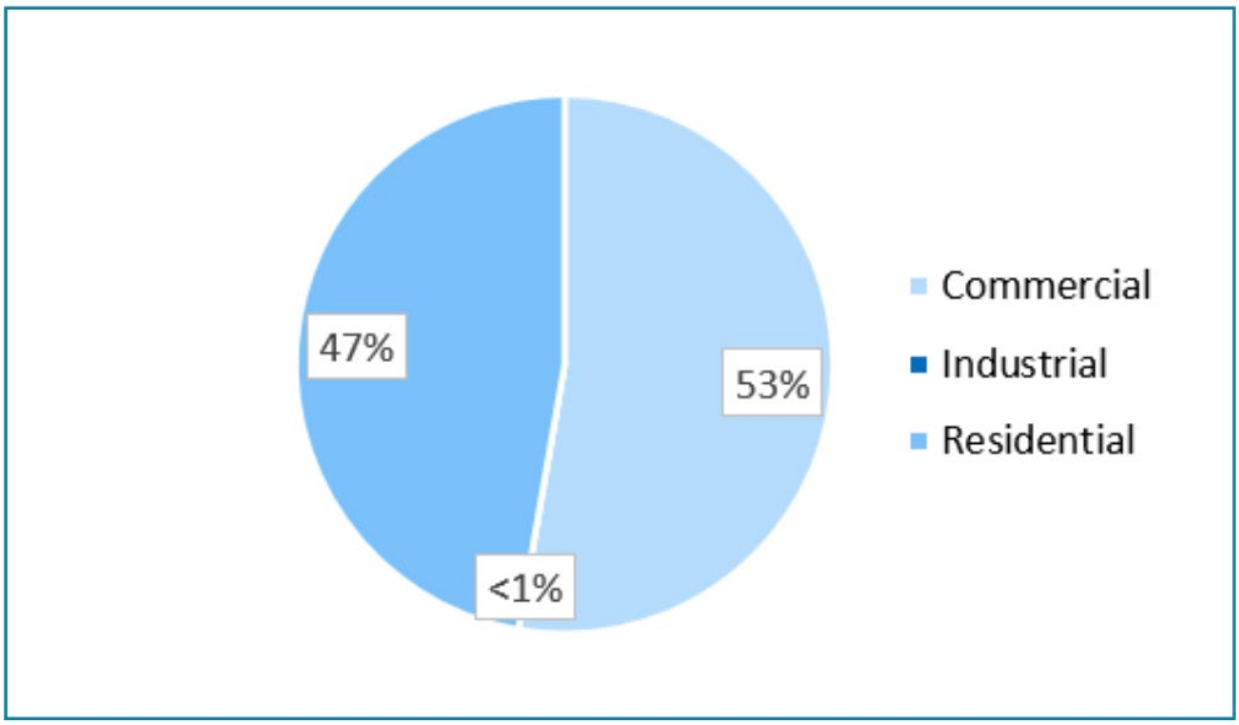
Built Environment

Electricity and natural gas use data for the built environment was provided by utilities for residential, commercial, and industrial end users. Electricity data is included from utilities Baltimore Gas and Electric (BGE) and Potomac Edison for the households and businesses they service. BGE accounted for 98% of the electricity used in Howard County in 2019. Natural gas data from BGE has been included. Research into the natural gas utility providers in the service area of Potomac Edison did not yield results, thus natural gas utilities data for a portion of the County is not accounted for. Assuming BGE provides natural gas and electricity for the same residential households, this gap represents 2% of households not covered.[3]

Emissions from purchased electricity and on-site fuel combustion account for 72% and 28% of the energy sector emissions total, respectively.

Default electricity emission factors from the 2019 RFC East eGRID subregion were used to estimate GHG emissions from electricity use.[4] Figure 1 shows a breakdown of energy sector emissions from Howard County in 2019 across commercial, residential, and industrial end-users. Emissions are close to evenly split between commercial and residential sectors, with 53% and 47% respectively.[5] Industrial end users represent less than 1% of total electricity use. This data includes emissions from both purchased electricity and on-site fuel combustion.

Figure 1. Energy Sector Emissions by Type of End-User



Transportation and Other Mobile Sources

Estimates of transportation sector emissions were derived using the vehicle miles traveled (VMT) for gasoline and diesel vehicles in Howard County and relevant emission factors. VMT data was taken from the 2019 mileage report developed by the Maryland Department of Transportation (MDOT) State Highway Administration (SHA) and included annual vehicle miles of travel by highway functional class. Functional classifications included are interstate, principal arterial other freeways and expressways, principal arterial other, minor arterial, major collector, minor collector, and local. Total VMT for Howard County in 2019 was estimated to be 4,362 million miles. According to the MDOT data used in the inventory, 1,462 million

miles of the total Howard County VMT were on interstates. Howard County government has limited control over the VMT associated with interstates, but decided to keep these miles in the total intra-County VMT to best represent actual emissions taking place within County borders.

As different types of vehicles have different fuel efficiencies and may even use different fuel types, converting VMT into GHG emissions requires information regarding the percentages of each vehicle type that make up the total vehicles driving in or through Howard County.

Table 1 provides a breakdown by vehicle and fuel types using the default values provided by ClearPath, which were derived from the EPA State Inventory Tool.[6]

Table 1. 2019 Percentage Breakdown of Vehicle Types (ClearPath)

Vehicle Type	Fuel Type		Percent of Total
	Gasoline	Diesel	
Motorcycles	0.0	0.0	0.0
Passenger Vehicles	60.6	0.3	60.9
Light Trucks	32.4	1.3	33.7
Heavy Trucks	0.0	5.4	5.4
Totals	93.0	7.0	100.0

When comparing this breakdown with the vehicle types in Howard County tracked by the State Highway Administration of Maryland for 2019, displayed in Table 2,[7] the ratio of passenger cars to light trucks differs significantly. Therefore, Howard County used the state data instead of ClearPath nationwide defaults to achieve more accurate results. The assumption made is that the ratio of passenger cars to light trucks in Howard County will be more similar to the ratio across the state of Maryland than to the ratio found nationwide.

Table 2. 2019 Percentage Breakdown of Vehicle Types (State Highway Administration of Maryland)

Vehicle Type	Percentage
Motorcycles	0.2
Passenger cars	79.4
Light trucks and other	13.4
Buses	0.8
Single unit trucks	3.3
Single trailer trucks	2.9
Multi trailer trucks	0.1

Howard County specific data also allows for the inclusion of electric vehicles in the breakdown. At the end of fiscal year in 2021, 278,885 vehicles were registered in Howard County.[8] Of these registered vehicles 3,698 were electric vehicles (EVs) and 1,794 were plug-in hybrid electric vehicles (PHEVS). As this data was not available for 2019, the assumption is made that the fraction of electric vehicles was approximately the same in 2019 as it was in 2021.

Using the percentages by vehicle type from the State Highway Administration of Maryland, ratio of gasoline to diesel vehicles by class provided by ClearPath, and excluding the electric vehicles, the inputs were updated as shown in Table 3.

Table 3. Proposed New percentage Breakdown of Vehicle Types

Vehicle Type	Gasoline	Diesel	Electric
Motorcycles	0.2	0	
Passenger Vehicles	79.0	0.4	0.02
Light Trucks	12.8	0.5	
Heavy Trucks	0.0	7.0	

Emission factors for each vehicle type were derived from data within ClearPath for 2019 U.S. National Defaults from the US Community Protocol developed by ICLEI (updated 2021).

Solid Waste

Estimates of emissions from the solid waste sector were derived from data provided by the County's Bureau of Environmental Services. This data includes all facilities that have Howard County waste in 2019. Data for 18 facilities in total are included, with three located within Howard County.[9] Total waste generated in 2019 is estimated at 312,930 tons including residential, commercial, industrial, and mixed. Residential waste is estimated to be 40% of total and commercial represents 60%, based on reporting from Howard County Bureau of Environmental Services to Maryland Department of the Environment. Within ClearPath, defaults were selected estimating the landfill methane collection scenario to be "typical", landfill moisture content to be "wet",[10] all waste types included.

Refrigerant Emissions

Refrigerant leaks can be an important source of emissions as these chemicals typically have high global warming potentials (GWPs). These emissions were estimated by scaling Maryland state refrigerant emissions for 2019 by the population of Howard County. Annual state level estimates can be found using the EPA's State Inventory Tool (SIT) and, for Maryland in 2019, are estimated to be 2,327,841 MT CO_2e.[11] The Howard County population was 5.4% of the state total, and thus County refrigerant emissions are estimated to be 125,404 MT CO_2e.

Wastewater and Water

Electricity used for wastewater collection and treatment was included within data provided by BGE. Associated emissions are thus accounted for in the built environment. Howard County did not include process emissions from operation of wastewater treatment facilities and operation of septic systems to allow for more consistent comparisons between the 2019 GHG emissions inventory and past inventories that did not include these emissions.

Fugitive Emissions

Research into industrial emissions was conducted using the EPA Greenhouse Gas Reporting Program (GHGRP). Certain industrial emitters above a threshold are required to report emissions to the GHGRP. Only two reporters for 2019 were identified: the Transcontinental Gas Pipe Line Corporation (Transco) Natural Gas Pumping Station 190 and Alpha Ridge Landfill. Emissions associated with the landfill are already accounted for within the inventory. Transco Station 190 reported emitted 71,694 MT CO_2e from stationary combustion and 4,212 MT CO_2e from petroleum and natural gas systems in 2019.[12, 13] Fugitive GHG emissions reported to EPA's GHGRP were included in the County's inventory.

Howard County Government GHG Emissions Inventory 2019

Although Howard County government operations are included in the overall communitywide GHG inventory, Howard County also calculated the emissions resulting solely from government operations.

The Local Government Operations Protocol developed by ICLEI states that all sources of emissions within government operations should be included and provides additional guidance on how to define an organizational boundary based on operational or financial control.[14] Under this accounting framework, the county government should not include GHG emissions from operations in which it has an interest, but no control. For example, emissions from the manufacture of products used in the county are not included in this accounting framework. The protocol indicates the criteria for operational control includes either: wholly owning an operation, facility or source; or having the full authority to introduce and implement operational and health, safety, and environmental policies. Autonomous departments (e.g., municipal utilities) may be managed by a board, but if county government has control over appointments to this board or oversight, then these departments are considered within government operational control and associated emissions should thus be included.

Data provided by Howard County estimate all government electricity usage in 2019 to have been 75.9 million kWh. Howard County provided data for purchased natural gas and diesel in 2019. Based on purchased natural gas, the County estimates that 709,995 therms of natural gas and 77,236 gallons of #2 ULS Heating Oil Dyed were consumed. This fuel was used for facilities such as Police, Fire and Rescue, Public Works, and Utilities.

To estimate County government fleet emissions, Howard County provided 2019 fleet data including make, model, type of fuel, daily consumption, and fuel efficiency. Total annual gasoline consumption was assumed to be 527,857 gallons and total diesel consumption 235,079 gallons. Vehicle classes (by gross vehicle weight) were grouped into the vehicle categories used in ClearPath, and the percentage of each vehicle type using gasoline or diesel was calculated (see Table 4). A rough estimate of County fleet emissions was made by summing daily consumption by fuel type and class, and then multiplying by an assumed number of working days (260 days). Knowing the fuel type and class is important to determining emissions because different types of vehicles have different average fuel consumption in miles per gallon and different emissions factors based on fuel efficiency and fuel type used.

Table 4. Percent of Vehicles Using Gasoline or Diesel Fuel by Functional Class for the Howard County fleet in 2019

ClearPath Vehicle Types	Class (Gross Vehicle Weight or GVW in tons)	Gasoline	Diesel
Motorcycles		0%	0%
Passenger Vehicles	<8,500 GVW	79%	2%
Light Trucks	8,501- 10,000 GVW; 10, 001- 14,000 GVW; 14,001- 16,000 GVW;	20%	17%
Heavy Trucks	16,001- 19,500 GVW; 19,501- 26,000 GVW; 26,001- 33,000 GVW; >33,000 GVW	1%	81%

Updates to 2005 Baseline GHG Inventory

Howard County's first Climate Action Plan, published in 2010, was based on 2007 and 2005 data. In order to best compare GHG emissions progress between our 2005 baseline and our 2019 inventory, Howard County made several modifications to the data from the 2010 CAP. These changes included:

- Used 2005 VMT numbers instead of 2007 numbers. 2007 estimates were interpolated between 2005 and 2009 values.
- Proxied sources that were not included in the original inventory based on available data (e.g., County population, state-wide estimates scaled to the County).
- Removed sources that were not included in the 2019 inventory (e.g., livestock)
- Updated global warming potentials to use IPCC's Fourth Assessment Report for consistency with the 2019 inventory

GHG Inventory Future Business as Usual (BAU) Projections

Future businesses as usual (BAU) GHG projections were developed using 2019 as a base year. For scopes 1 and 3, estimates were developed based on the emissions calculated within ClearPath. BAU assumptions for the electricity grid followed the predicted changes to grid mix following the Annual Energy Outlook 2021 (AEO) developed by EIA. 15 Sector-specific assumptions are described below.

Most emission sources were assumed to increase proportionately with population growth, with a few exceptions. Population projections for all years from 2020 – 2050 were calculated using the historical and projected population data of Howard County. Data on the historical population from 2010-2019 was collected from the U.S. Census Annual Estimates of the Resident Population for Counties in Maryland.[16] Population projections for 2015-2045 were developed in 5-year intervals from the Maryland Department of Planning. Historical and projected population for Howard County is shown below in Table 5.[17]

Table 5. Howard County Population Projections 2015 – 2045

	2015	2020	2025	2030	2035	2040	2045
Population	313,350	327,990	344,150	356,860	364,640	368,830	369,220

On-Site Combustion

On-site fuel combustion was calculated separately for both the residential, commercial, and government[18] sectors. On-site fuel combustion was assumed to grow at the same rate as Howard County population for all years except 2020. 2020 fuel consumption was adjusted based on analysis from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020.[19] This analysis showed that commercial sector emissions due to natural gas combustion shrank by 9.9% compared with 2019, while residential usage shrank by 6.9%. Years post-2020 were projected based on 2019 data.

Transportation

For all years after 2021, transportation emissions were assumed to grow at the same rate as Howard County population growth for both the County and government inventories. Activity data for both 2020 and 2021, across both inventories, were adjusted due to the COVID-19 pandemic. Annual VMT data was found from the Maryland Department of Transportation (MDOT), shown in Table 6.[20] Transportation emissions for both inventories for 2020 and 2021 was determined using the ratio of 2019 annual VMT compared with the desired year multiplied by 2019 emissions.

Table 6. Howard County Annual VMT for 2019-2021

	Annual VMT in Howard County (millions)	Percent of 2019 VMT
2019	4,362	
2020	3,640	83%
2021	4,044	93%

Starting in 2022, the “avoided” on-road emissions due to assumed EV uptake in the County is subtracted from the baseline projection scenarios.

Waste

Both scope 1 and scope 3 waste emissions were assumed to grow at the same rate as Howard County population growth.

Refrigerant Emissions

Refrigerant emissions were assumed to remain constant over the calculated time period, due to competing factors of population growth, potential building stock changes, refrigeration equipment stock turnover, and the impact of policies such as the AIM Act to phase down high-GWP refrigerants in the coming years for new equipment.

Purchased Electricity

Calculations for scope 2 emissions were based on the electricity usage data provided by Howard County. Purchased electricity was assumed to grow at the same rate as Howard County population for all years except 2020. 2020 electricity usage was adjusted based on analysis from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020.[21] This analysis showed that commercial sector electricity usage shrank by 9.6% compared with 2019, while residential usage grew

by 1.7%. Government electricity usage was assumed to decrease at the same rate as commercial. Years post-2020 were projected based on 2019 data. Based on the purchased electricity data, the U.S. Energy Information Administration's Annual Energy Outlook (AEO) projection scenario was used to estimate future electricity grid mix. Both scenarios are built using emission factors calculated from RFC East eGRID data.[22] The AEO projection scenario scales 2019 grid factors based on policies currently "on the books", across future years. The impact of the Maryland Renewable Portfolio Standard (RPS) was included in the mitigation scenario. The RPS provides a minimum percentage of the electricity used in Maryland that needs to come from renewable sources by specific years.

Following 2022, additional load from EVs is added to baseline projections of electricity consumption. 80% of this additional load is assumed to take place at residential locations with 20% at commercial- locations.[23]

Fugitive Emissions

Fugitive emissions from GHGRP reporter Transco Station 190 were assumed to remain constant over the calculated time period and are based on a 3-year average of data.

Suggestions for Inclusion in Future Inventories

- Include emissions from other stationary fuels (e.g., fuel oil, kerosene). Government operations emissions calculations included fuel oil, diesel, natural gas, and other stationary fuels, but this information wasn't as widely available for the rest of the community in the 2005 and 2019 inventories. Approximately 2% of the County's population is not serviced by the main natural gas provider (BG&E), and natural gas use in that area was assumed to be minimal or non-existent. Future inventories could include this information from other natural gas providers to Howard County.
- Include emissions from off-road mobile equipment (e.g., lawnmowers, construction equipment)
- Confirm no additional sources of industrial emissions occur in the County, and that the TransCo stationary combustion emissions are included in the commercial sector estimates.
- Include freight rail and other sources that were not included in the current inventory, as listed in the ICLEI Protocol
- Expand on scope 3 waste estimates based on destinations of landfill (i.e., the County could improve the accuracy of its estimate by reflecting specific landfill characteristics of the landfills receiving its waste)
- Consider estimating emissions of Sulphur hexafluoride (SF_6) from electricity transmission and distribution lines within the County's boundaries. SF_6 is a greenhouse gas with a high global warming potential (GWP) of 22,800, compared to a GWP of 1 for carbon dioxide.
- Confirm electricity emission factors with any in-County electricity generating units.
- Explore the feasibility of estimating emissions from other wastewater treatment methods (e.g., septic systems)
- Consider adding other upstream/downstream sources of emissions
- Agriculture and land use-related sources and sinks (carbon storage) could include:
    - Livestock-related emissions, including both enteric fermentation and manure management
    - Soil N_2O emissions
    - Sequestration and C flux changes from land use and land use conversions for forestland, grassland, agricultural land, etc.
    - Sequestration from urban trees
    - Emissions from forest fires and agricultural residue burning

[1] ICLEI U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions Version 1.2, July 2019. Accessed online at: https://icleiusa.org/us-community-protocol/

[2] ICLEI notes that the energy use associated with water and wastewater infrastructure may also partially or fully be included in the use of purchased electricity and stationary combustion equipment.

[3] U.S. Census data from 2016 -2020 estimates Howard County has 116,457 households. Data provided by Howard County indicates that 114,170 households receive electricity from BGE, or 98% of Howard County households. U.S. Census Bureau. Retrieved from https://www.census.gov/quickfacts/fact/table/howardcountymaryland/AFN120217

[4] Environmental Protection Agency. eGRID Summary Tables 2019. https://www.epa.gov/sites/default/files/2021-02/documents/egrid2019_summary_tables.pdf

[5] Industrial emissions total 220 MT CO_2e in 2019.

[6] Environmental Protection Agency. State Greenhouse Gas Inventory and Projection Tool. https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool

[7] State Highway Administration of Maryland. https://www.roads.maryland.gov/OPPEN/annual_vehicle_Class.pdf

[8] MVA Vehicle Registration by County from 2010 to 2022. https://opendata.maryland.gov/Transportation/MVA-VEHICLE-REGISTRATION-by-COUNTY-FY-2010-to-FY-2/kqkd-4fx8

[9] Facilities located within Howard County include Alpha Ridge Municipal Landfill, Ameriwaste Processing & Transfer Station, and Citron Hygiene Transfer Station.

[10] ClearPath indicates "wet" should be selected for annual precipitation of greater than 40 inches per year.

[11] Environmental Protection Agency. State Greenhouse Gas Inventory and Projection Tool. https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool

[12] Environmental Protection Agency. GHGRP Data for Transco Station 190 in 2019. Accessed online at: https://ghgdata.epa.gov/ghgp/service/facilityDetail/2019?id=1006953&ds=E&et=&popup=true

[13] "Petroleum and natural gas systems" includes fugitive emissions.

[14] Local Government Operations Protocol, Version 1.1, May 2010. Accessed online at: https://s3.amazonaws.com/icleiusaresources/lgo_protocol_v1_1_2010-05-03.pdf

[15] Energy Information Administration. Annual Energy Outlook 2021.Table 54. Electric Power Projections by Electricity Market Module Region; https://www.eia.gov/outlooks/archive/aeo21/

[16] U.S. Census Bureau. County Population Totals: 2010-2019. https://www.census.gov/data/datasets/time-series/demo/popest/2010s-counties-total.html

[17] Maryland Department of Planning, Projections and State Data Center (December 2020). Historical and Projected Total Population for Maryland's Jurisdictions. https://planning.maryland.gov/MSDC/Documents/popproj/TotalPopProj.pdf

[18] Community-scale commercial and residential on-site combustion only included natural gas. Government emissions include both natural gas and #2 ULS Heating Oil Dyed. In 2021 approximately 83% of on-site fuel combustion government emissions were due to natural gas.

[19] Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. Chapter 3: Energy. https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-chapter-3-energy.pdf

[20] Maryland Department of Transportation – State Highway Administration. Vehicle Miles of Travel. https://www.roads.maryland.gov/oppen/Vehicle_Miles_of_Travel.pdf

[21] Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. Chapter 3: Energy. https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-chapter-3-energy.pdf

[22] Environmental Protection Agency. eGRID2019 Unit, Generator, Plant, State, Balancing Authority Area, eGRID Subregion, NERC Region, U.S., and Grid Gross Loss (%) Data Files. February 23, 2021. https://www.epa.gov/sites/default/files/2021-02/egrid2019_data.xlsx

[23] Blonsky, Michael, Prateek Munankarmi, Sivasathya Balamurugan. 2021. Incorporating Residential Smart Electric Vehicle Charging in Home Energy Management Systems: Preprint. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5D00-78540. https://www.nrel.gov/docs/fy21osti/78540.pdf

Appendix F: Mitigation Analysis Assumptions and Methods

Buildings and Energy Use Strategies

In the Energy Strategies section, there are three major ways in which emissions are reduced. First, by using less energy than anticipated from the business as usual (BAU) projection through the implementation of energy efficiency or green building techniques. Second, by switching equipment out from one energy source to a cleaner energy source (as is the case with electrification). Third, by cleaning the energy supply through the integration of low and no carbon resources (this happens from new carbon free sources on the electricity grid, such as solar or wind energy, or by the addition of renewable natural gas into the gas system).

The modeling took a simplistic approach to costs, pricing all equipment without cost changes over the life of the technology and holding utility rates at current utility rates for the range of years studied. This approach provides for a highly replicable and transparent methodology. Methodology assumptions below include a base mitigation modeling methodology and an enhanced mitigation modeling methodology, with all modeling for the base mitigation modeling unless noted otherwise.

Strategy E1: Reduce Greenhouse Gas Emissions from Existing Buildings

Action 1: Increase energy efficiency and conservation in all existing residential, commercial and government buildings

Methodology

ICF begins by taking cost-effective energy efficiency potentials for residential, commercial and government buildings. For electricity, we assume 30% residential savings and 25% for commercial and government buildings. For gas, we assume 20% savings across all buildings. We then phase in these reductions annually until 100% of the building stock realizes these reductions by 2045. It is assumed a suite of technical and behavioral measures are used to reach these savings – technical measures could include air sealing, insulation, high-efficiency appliances, and smart thermostats, among others. Behavioral measures could include providing education information, leveraging social norms, and other techniques that encourage building occupants to use less energy. All equipment changes in the model are “replaced on burnout” in alignment with cost effective energy efficiency values outlined below. This means that the modeling assumes new equipment is only installed when equipment reaches the end of its useful life (at which time the equipment is replaced with a more efficient piece of equipment). As a result of this approach, modeled costs represent only the incremental cost between more and less efficient new equipment and the costs of any other energy efficiency measures that are not replacing old equipment, not the total anticipated costs which would be inclusive of maintaining all equipment, as equipment maintenance costs are likely to be similar between old and new equipment.

Key Assumptions

- Targets existing residential, commercial and government buildings
- Cost-effective electricity energy efficiency potential of 30% in residential buildings[12] and 25% in commercial and government buildings.[3] Annual building stock-wide electricity savings begin at 0.5%, ramping up to 3% for residential and 2.5% for commercial and government by 2045. The changes within these rates were chosen based on the expectation that energy efficient equipment will become more widely available and cost effective over time.

- Cost-effective gas efficiency savings of 20% across all buildings. Annual gas savings begin at 1.1% ramping up to 2% by 2045.
- 20-year measure life, with replacement by like measures at end of life.
- Replacement on burnout for measures, capturing only incremental cost of efficient vs. conventional equipment. This is because it is unlikely residents and businesses will upgrade equipment before it breaks.
    - $3,500/household for residential measures[4]
    - $1.91/sq. ft. for commercial measures[5]
- Electricity price of $0.125 /kWh, natural gas price of $14.00/MCF[6]
- No additional operations and maintenance costs since new equipment is assumed to have similar operations and maintenance costs as existing equipment.

Action 2: Increase electrification in existing residential, commercial and government buildings

Methodology

The strategy takes BAU natural gas and fuel oil consumption and converts it to electricity, gaining efficiency via beneficial electrification measures. By 2030, it is assumed that 20% of residential homes and 10% of commercial and government will be electrified.[7] By 2045, 80% of residential and 59% of commercial and government buildings will be electrified. Linear interpolation is used between these targets for a steady adoption rate. These adoption values are considered realistic due to the aggressive legislation that has passed in Maryland and the relative cost effectiveness of electrification in the residential marketplace. In its Maryland Building Energy Transition Plan[8], the Maryland Climate Change Commission recommended the State include rebates and incentives to support fuel switching and beneficial electrification programs through their EmPOWER program starting in 2024. In the commercial space, The Climate Solutions Now Act of 2022 mandated a pathway of zero carbon commercial buildings including broad electrification of existing buildings to achieve net-zero emissions by 2040. Residential gas use is converted to electricity via 8.2 Heating Seasonal Performance Factor (HSPF) air source heat pump (which aligns with ENERGYSTAR's current efficient heat pump equipment). Commercial and government gas use is converted to electricity using a conservative 18% efficiency gain (based on a 2020 national study of electrification in commercial buildings). This value is considered conservative due to Maryland's average air temperatures, which should allow more efficient and effective electric heating than can be expected in areas with colder climates. All equipment is "replaced on burnout," and therefore only incur incremental costs, as described in the energy efficiency strategy above. At the end of measure life, new equipment replaces existing equipment.

Key Assumptions

- Targets existing residential, commercial and government buildings
- By 2030, 20% residential buildings using gas or oil are converted to electric and 10% of commercial and government buildings using oil or gas are converted to electric. By 2045, 80% of residential buildings using gas or oil are converted to electric and 59% of commercial and government buildings using oil or gas are converted to electric.
- Electrification GHG reductions are based on using an 8.2 HSPF heat pump for residential buildings[9] and applying 18% efficiency gain for commercial and government buildings.[10] Although electrification can include appliances such as dryers and stovetops, heating, ventilation, and air conditioning (HVAC) tends to be one of the largest electric loads in a building. Therefore, the modeled GHG emissions reductions are based on energy savings from electrifying heating systems.
- 15-year equipment measure life, with replacement by like equipment at end of life.

- Replace on burnout for measures, capturing only incremental cost:
    - $3,500/house incremental capital cost for residential,[11]
    - $18.48/sq. ft. capital cost for electrification of commercial and government buildings. Costs ranged from $8.48 - $23.68 in the study referenced, so this was calculated as the average incremental capital cost for commercial and government buildings.[12] Over time as electrification technologies are more broadly adopted, costs are anticipated to come down through contractor familiarity and technology improvements.
- Electricity price of $0.125 $/kWh, natural gas price of $14.00/MCF.[13]
- No additional operations and maintenance costs for energy efficient equipment.

Action 3: Accelerate the adoption of low GWP refrigeration and air conditioning equipment in commercial properties and reduce refrigerant leaks.

Refrigerant leaks can be an important source of emissions as these chemicals typically have a high global warming potential (GWP). The AIM Act passed in 2020 phases out hydrofluorocarbons (HFCs) over time in favor of lower-GWP alternatives. Howard County can create a program promoting the use of low GWP refrigerant equipment and performing frequent maintenance to reduce refrigerant leaks in commercial properties (e.g., encourage local businesses to enroll in the federal GreenChill program).

Methodology

Refrigerant emissions from the food retail sector was estimated using a total count of food retail stores in Howard County, estimated square footage for each type of store, and an assumed refrigerant leakage rate per 1,000 sq. ft. The model assumes enrollment of retail food stores in GreenChill (or a similar program), results in a drop in emissions.

Key Assumptions

- BAU projections assume that HFC refrigerant emissions remain flat through 2045. Retail food locations are expected to grow at the same rate as population.
- As of 2022, Howard County has 152 food retail stores. These include: 83 convenience stores; 37 supermarkets; and 32 small grocery/corner stores.[14]
- An estimate of emissions due to refrigerant leakage per 1,000 sq. ft. for supermarkets was developed using analysis conducted by the GreenChill Program.[15] The average 46,000 sq. ft. supermarket emits 1,556 metric tons of carbon dioxide equivalent (MT CO_2e) of refrigerant per year.
- An average square footage for each category of food retail store is assumed. Convenience store – 2,450 sq. ft.;[16] small grocery/corner store – 12,000 sq. ft.;[5] supermarket – 46,000 sq. ft.[17]
- The GreenChill program helps participating retailers improve their refrigerant management practices, transition to alternative refrigerants, and set and track progress toward GHG reduction goals.[18] GreenChill Partners in the food retail industry have refrigerant emissions rates nearly 50% lower than the EPA-estimated industry average. This model assumes that as food retail locations enroll in GreenChill (or a similar program) emissions reduce by half.[19]
    - Currently only 1 store in Howard County is enrolled in the GreenChill program (Sprouts in Ellicott City, MD).[20]
- By 2030, 34% of Howard County retail food stores are enrolled in GreenChill (or a similar program).
- By 2045, 83% of Howard County retail food stores are enrolled in GreenChill (or a similar program).

Strategy E-2: Construct Efficient and Low-Carbon Buildings

Action 1: Implement more stringent green building standards for new residential, commercial and government properties.

Methodology

Historic Howard County building permit records were used to project forward new construction. The average residential growth rate from 2006-2022 was applied to future years, and the average commercial growth rate from 2018-2022 was applied to future years. Commercial growth intentionally weighted COVID-19 impacted years to reflect a presumed decrease in demand for new commercial office space.

Once growth projections were determined, new IECC (residential) and ASHRAE 90.1 (commercial and government) codes were applied to new construction. Based on historical improvements to codes, ICF estimated energy efficiency expected due to new code improvements. ICF also worked to define through modeling a green building standard or overlay code. Modeling accounts for codes to be updated every 3 years and above code standards (green building standards or overlay code) to stay one code cycle ahead of current version of IECC/ASHRAE code, with each subsequent code version resulting in a 5% reduction in energy use intensity (EUI) which is the energy use including electricity and any other fuel sources per square foot. Howard County assumed a 95% compliance rate with new energy –efficiency-focused code.

Only incremental capital costs are included in the model. Incremental cost is the additional cost of constructing a building to the new green building code standard compared to the cost of constructing the same building under the International Construction Code. Commercial capital costs are negative because even though there may be a small added cost from tighter, better insulated building envelopes, these energy efficiency improvements also allow the building to use smaller, less expensive heating and cooling equipment, which results in a slight overall cost savings over construction under the International Construction Code. At the end of measure life, like equipment replaces existing equipment.

Key Assumptions

- Targets new residential, commercial and government buildings
- Average annual new construction rate from 2006-2022 for residential, 2018-2022 for commercial.
- 5% efficiency gain with each subsequent code cycle.[21]
- 95% compliance rate with new energy-efficiency focused code.
- Incremental cost of code adoption (including electrification):
    - $3,687/house incremental capital cost for residential,[22]
    - -$1.50/sq. ft. incremental capital cost for commercial and government buildings (due to equipment downsizing)[23]
- Electricity price of $0.125 $/kWh, natural gas price of $14.00/MCF[24]
- No additional operations and maintenance costs

Action 2: Phase-in requirements for all-electric new construction for residential, commercial and government properties.

Methodology

All-electric new construction is assumed to begin in 2025 for 100% of residential properties and 38% of commercial and government properties. All-electric commercial construction is implemented beginning in 2035. Both assumptions align

broadly with Maryland's plans for a Building Emissions Standard and associated updated building codes as outlined in recent planning documents.[25] Residential gas use is converted to electricity via 8.2 HSPF air source heat pump. Commercial and government gas use is converted to electricity using a conservative 18% efficiency gain.

Only incremental capital costs are included in the model. Incremental cost is the additional cost of constructing a building to the new green building code standard compared to the cost of constructing the same building under the International Construction Code. Commercial capital costs are negative because even though there may be a small added cost from better insulated building envelopes, these improvements also allow the building to use smaller, less expensive heating and cooling equipment. This results in a slight overall cost savings over construction under the International Construction Code. At the end of measure life, like equipment replaces existing equipment.

Key Assumptions

- Targets new residential, commercial and government buildings
- Average annual new construction rate from 2006-2022 for residential, 2018-2022 for commercial.
- 5% efficiency gain with each subsequent code cycle.[26]
- 95% compliance rate with new energy-efficiency focused code.
- 2025: 100% residential electrification, 38% commercial and government electrification
- 2035: 100% building electrification across residential, commercial and government
- 8.2 HSPF heat pump for residential buildings,[27] 18% efficiency gain for commercial and government buildings[28]
- 15-year equipment measure life, with replacement by like equipment at end of life.
- Incremental cost of code adoption (including electrification):
    - $3,687/house incremental capital cost for residential,[29]
    - -$1.50/sq. ft. incremental capital cost for commercial and government buildings[30] (due to equipment downsizing)
- Electricity price of $0.125 $/kWh, natural gas price of $14.00/MCF[31]
- No additional operations and maintenance costs

Strategy E3: Decarbonize the Energy Supply

Anticipated Grid changes from MD Renewable Portfolio Standard (RPS), etc. without specific Howard County government action (not a named or numbered strategy in Howard County Climate Forward)

Methodology

This strategy explored two possibilities for changes to the electricity grid carbon intensity in addition to the base case for the grid.

- The base case grid assumes that the grid carbon intensity matches recent regional grid emissions rates from EPA's eGRID[32] (RFC East) and follows the same carbon intensity trends from the 2022 Annual Energy Outlook (AEO)[33]. The emissions for the BAU were calculated using in grid emissions factors from this base case grid.
- The existing policy methodology aimed to align with Maryland's current RPS of 50% of electricity from regional renewable energy sources by 2030.
- The enhanced policy methodology implements the existing Maryland RPS and expands it to a proposed 100% carbon-free electricity statewide by 2035 in alignment with the Biden Administration's electricity grid carbon reduction goals. This would require new state legislation.

In both cases, emissions from renewable electricity were set at zero and implementation of the renewable energy was seen as a change from the planned AEO base case grid policy scenario. Emissions reductions are above and beyond AEO Grid Policy Scenario which serves as the baseline for reductions. This is not the result of a Howard County government action but can demonstrate the GHG impact of a zero-carbon grid.

Howard County included Maryland's current RPS of 50% of electricity from regional renewable energy sources by 2030 in emissions reduction calculations for Strategy E3 because even though this isn't a County action, it is something that is currently happening and was not reflected in the emissions outlook for 2030 or 2045 in any other way in the mitigation analysis.

Action 1: Expand the development of solar energy for residential, commercial, and government properties

Methodology

A 2018 rooftop solar technical potential of 1,100 MW DC was calculated using Project Sunroof information.[34] Project Sunroof estimates rooftop based on arial mapping, which estimates technical potential constraints such as shading, roof angle as well as a regional solar resource.[35] The Technical potential represents the achievable capacity (MW) of rooftop solar photovoltaic (PV) given existing system performance as well as rooftop constraints. Technical potential does not account for economic barriers or market considerations. Future rooftop solar technical potential was tied to population growth rates (and the associated increase in new construction and new roofs available for solar), resulting in a maximum achievable potential of 1,259 MW DC of rooftop solar by 2045. A phase-in factor implements linear interpolation (straight line of growth) towards achieving 90% of technical potential in 2045, or 1,133 MW DC.

Howard County solar permitting data was then analyzed to derive the existing installed capacity of 82 MW on rooftops in 2022. A BAU growth in new rooftop solar installations of 6.9 MW was forecasted annually through 2050 based on the median growth in these installations from 2018-2022. Electric grid kWh reductions and associated CO_2e reductions from the actions in this strategy do not include this BAU growth as doing so would double count the impact and show it both in the BAU and the post-strategy-implementation calculations.

Key Assumptions

- Targets existing and new residential, commercial and government buildings.
- Uses a high rate of implementation of rooftop solar (90 percent of technical capacity by 2045) as a proxy to account for the fact that actual rooftop solar installation may be less than 90 percent of technical capacity, but that parking canopy solar and ground mount solar also will be installed and isn't otherwise accounted for in this model.
- 2018 solar technical potential of 1,100 MW DC. Adjusting for population growth and associated new construction and new roofs, the solar technical potential in 2045 is projected to be 1,259 MW DC.
- 82 MW existing solar capacity and 6.9 MW BAU growth[36]
- 1379.5 kWh AC/year from a 1 kW DC array in Howard County which is used to scale kWh production per kW DC installed[37]
- 30-year measure life
- Cost per kW was set at $1624/kW for weighted cost of residential and commercial solar[38]
- Electricity price of $0.125 $/kWh
- No additional operations and maintenance costs since studies show actual O&M costs to be very small (less than 2% of capital costs annually) and they would have an extremely small impact on the results.

Transportation Strategies

Strategy T1: Maximize the Use of Electric Vehicles

Action 1: Continue to develop a robust EV charging station infrastructure

Methodology

ICF obtained the total number of existing publicly-accessible chargers within Howard County using raw data from the AFDC Electric Vehicle (EV) Charging Station Locations map. Next, we applied the regression model developed by Javid et al. 2019[39] to estimate EV adoption rates in Howard County using Howard County demographics, energy costs, and home ownership data in addition to assumed numbers of chargers in 2030 and 2050. In order to achieve an EV penetration of 74% of all passenger vehicles, ICF assumed that the number of chargers would double every 5 years through 2042 and increase by 1,000 every 5 years through 2050. Baseline projected EV adoption rates by vehicle class developed by NREL[40] was subtracted from the regression model projected adoption rate. The change in adoption rate over baseline for each vehicle class was multiplied by non-interstate vehicle miles traveled (VMT) by vehicle class to calculate the increase in EV VMT and decrease in ICE VMT. Non-interstate was chosen because EV chargers in Howard County are anticipated to have little effect on pass-through vehicle propulsion type choice. AEO (or BAU) grid emissions assumptions applied throughout the analysis were used to calculate the anticipated additional emissions from additional grid load from EVs. As described in strategy E3, AEO scenario electricity grid factors were used to determine the electricity emissions changes as a result of this activity. Net emissions change was the difference of emissions reductions from reduced ICE VMT and additional emissions from additional grid load from electric vehicles.

Key Assumptions

- Regression model coefficients used to estimate electric vehicle adoption rate based on charging infrastructure deployment were developed by Javid et al. 2019[41]
- Regression model data:
    - Age[42]
    - Gender[43]
    - Number of vehicles per household[44]
    - Maximum education level in household[45]
    - Home ownership[46]
    - Gas Price[47]
    - Electricity Price[48]
    - Average travel time to work (min)
- 2022 number of chargers found by using the AFDC Electric Vehicle Charging Station Locations map data and filtering for chargers located within Howard County. Data accessed on August 30, 2022. https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC
- 400 publicly available chargers by 2030 and 2,600 by 2045. This estimate is in line with industry recommendations.[49]
- Gas prices, at $0.16/mi, and electricity prices, at $0.04/mi, held constant

- Electric vehicle efficiency values (kWh/mi) based on AFLEET 2020[50] defaults with a 15% efficiency improvement by 2050

Assumed EV Energy Economy (kWh / mi)				
	2018	2022	2030	2050
Pass. Cars	0.30	0.29	0.28	0.26
Pass. Trucks	0.600	0.59	0.57	0.51

Please note that although the above methodology shows that installing additional EV charging stations throughout the County is a critical step to encourage the adoption of EVs by members of the community, Howard County did not use this methodology to estimate the GHG emissions reductions expected from increased adoption of EVs. Instead, this methodology was used to determine a target number of publicly available EV charging stations in Howard County on public and private property. The emissions reductions from EV adoption by the community was captured through analysis used for T1 – Action 2 below. In order to avoid double counting emission reductions, Howard County only used emissions reduction numbers calculated for one of the actions related to increasing EV adoption in the community.

Action 2: Accelerate the adoption of electric vehicles in the community and County government fleet.

Methodology for County Fleet

Baseline fuel consumption is estimated for one year by summing the product of annual work days and the daily consumption for each vehicle in the Howard County government fleet.

Scenario fuel consumption is estimated for each year by replacing vehicles once they reach 15 years of age with an electric vehicle of the same class. Assumed efficiencies of replacement electric vehicles vary by class and by procurement year, and are based on AFLEET 2020 defaults. Once an electric vehicle reaches 15 years of age, it is replaced with another electric vehicle of the same class but has an updated efficiency.

Change in total fuel use and associated emissions between the baseline and scenario fleets is calculated. Next, total additional grid load from new electric vehicles is summed by using the product of efficiency (kWh/mi) and annual VMT derived from the provided daily fuel use and fuel economy. AEO grid emissions assumptions applied throughout the analysis were used to calculate the anticipated additional emissions from additional grid load from electric vehicles. Net emissions change was the difference of emissions reductions from reduced ICE fuel usage and additional emissions from additional grid load from electric vehicles.

With these assumptions, a 100% EV fleet will be reached by 2037.

Key Assumptions

- 260 work days per year
- Analysis based on existing fleet and fuel use information from Howard County
- All county fleet vehicles (across all vehicle classes) are replaced with electric vehicles once they reach 15 years of age. This assumes that all vehicle classes will have an EV option by the time of vehicle replacement.
- County vehicle driving profiles remain the same, and the fleet does not change in size.
- Vehicle efficiency values (kWh/mi) based on AFLEET 2020[51] defaults with a 15% efficiency improvement by 2050

- When electric vehicles reach 15 years of age, they are replaced with another vehicle with the latest efficiency value.
- We anticipate that supply chain and scaling issues impacting EV availability will resolve in the next few years as the technology matures and should not impact long-term EV needs.

Methodology for Community Fleet

This action focuses on increasing the rate of EV adoption by the community through a combination of adding new EV charging infrastructure, educating community members about EVs and new rebates available from the state and federal government, as well as anticipated adoption of EVs as the market trends toward EVs in the future.

The adoption rate was assumed to be 50% of new light-duty passenger car and truck sales are EVs in 2030 and that by 2040, 100% of new vehicle sales are EVs. The adoption rate for each vehicle class was multiplied by non-interstate vehicle miles traveled (VMT) by vehicle class to calculate the increase in EV VMT and decrease in ICE VMT. Non-interstate was chosen because EV chargers in Howard County are anticipated to have little effect on pass-through vehicle propulsion type choice. AEO (or BAU) grid emissions assumptions applied throughout the analysis were used to calculate the anticipated additional emissions from additional grid load from EVs. As described in strategy E3, AEO scenario electricity grid factors were used to determine the electricity emissions changes as a result of this activity. Net emissions change was the difference of emissions reductions from reduced ICE VMT and additional emissions from additional grid load from electric vehicles.

Key Assumptions

- 50% of new light-duty passenger car and truck sales are EVs in 2030; 100% of new vehicle sales are EVs by 2040.
- Assumed vehicle efficiency values (kWh/mi) based on AFLEET 2020 defaults
- When electric vehicles reach 15 years of age, they are replaced with another vehicle with the latest efficiency value.

Action 3: Transition to a zero-emissions transit vehicle fleet.

Methodology

We retrieved information about Howard County's transit fleet from the Bureau of Transportation Statistics' (BTS) National Transit Database (NTD). This fleet includes buses, cutaways, and automobiles used for fixed route and demand responsive service types. Numbers were then verified and adjusted as needed by Howard County's Office of Transportation.

Baseline average annual miles per vehicle was calculated by dividing the VMT by fuel type from "Fuel and Energy Static" NTD 2019 table and the "Vehicles Static" NTD 2019 table number of buses, cutaways, and automobiles used for fixed route and on demand transit. By doing this, an average annual VMT was calculated for each vehicle type.

Baseline fuel use and emissions were calculated by using the NTD 2019 fuel use totals and assumed fuel emissions rates.

Scenario fuel use was calculated by linearly interpolating the number of EVs such that 100% EV transit fleet is achieved by 2040. Average annual miles per vehicle was multiplied by each vehicle and each fuel type in each year to obtain miles traveled on each fuel. The NTD 2019 mpg and kwh/mi were multiplied by the total VMT by fuel type to obtain fuel use in each year. Fuel used was multiplied by assumed emissions factors or grid emissions factors to obtain total emissions.

The difference between baseline fleet emissions and scenario fleet emissions was the emissions reduction.

Key Assumptions

- Conversion to EV buses only (i.e., no hybrid, hydrogen fuel cell, or catenary wire buses)

- Based on 2019 NTD data
- Transit service stays the same as 2019 in all modeled years
- Only Howard County RTA modeled, MTA not modeled
- kWh/mi projected to decrease over time as more efficient electric propulsion systems are developed

Action 4: Transition to a zero-emissions school bus fleet

Methodology

Annual VMT for the existing school bus fleet is estimated by calculating an average annual mileage for each vehicle (total mileage divided by the number of years in service) and summing.

Baseline emissions were calculated by multiplying this VMT by an assumed school bus emissions factor and fuel economy.

Scenario emissions are estimated for each year by replacing school buses once they reach 12 years of age with an electric school bus. Assumed efficiencies of replacement school buses are based on AFLEET 2020 defaults. Once an electric school bus reaches 12 years of age, it is replaced with another electric school bus but has an updated efficiency. Total additional grid load was summed by multiplying the average annual VMT by the fuel efficiency (kWh/mi). Grid emissions assumptions applied throughout the analysis were used to calculate the anticipated additional emissions from additional grid load from electric school buses. Net emissions change was the difference of emissions reductions from reduced ICE school bus fuel usage and additional emissions from additional grid load from electric school buses.

Key Assumptions

- 180 school days per year
- All school buses are replaced with electric vehicles once they reach 12 years of age. The fleet will consist of 393 (73%) electric school buses by 2030 and 535 (100%) electric school buses by 2045.

Assumed EV Energy Economy (kWh / mi)				
	2018	2022	2030	2050
School Buses	1.5	1.47	1.42	1.28

- Vehicle efficiency values (kWh/mi) based on AFLEET 2020 defaults with a 15% efficiency improvement by 2050
- ICE school bus MPG provided by US AFDC[52]
- When school buses reach 12 years of age, they are replaced with another vehicle with the latest efficiency value.
- Each school bus maintains a constant annual average VMT.

Strategy T2: Reduce Vehicle Miles Traveled in Single Occupancy Vehicles

Action 1: Increase public transit ridership by enhancing the effectiveness and reliability of local and regional public transit.

This action was not independently modeled.

Action 2: Implement microtransit in less dense areas that have a demonstrated need of connection between homes, jobs, and services.

Methodology

Baseline tailpipe emissions for passenger vehicles were calculated through 2045. This total was reduced by 3.8% per year to account for the addition of microtransit service in the county. The difference between baseline and the adjusted emissions totals was the emissions reductions due to the action.

Although these emissions reductions may be a bit high because Howard County microtransit is likely to take place on a smaller scale than it did in the studies cited in the assumptions below, several of the actions that are intended to reduce VMT were not modeled and therefore have no emissions reduction numbers assigned to them. Therefore, having an action where emissions reduction estimates may be slightly high can make up for the actions under T2 that do not have modeled reductions assigned to them.

Key Assumptions

- 3.8% VMT and proportional emissions reduction on baseline emissions in Howard County due to microtransit, based on research in Canada.[53] In the Canadian study, baseline GHG levels were calculated based on vehicle occupancy rate, emissions rates, and inefficiency assumptions (e.g. 20% inefficiency for paratransit trips). For projected GHG reductions, total number of journeys and distance travelled were kept the same. Interviews and expert input informed the likely switching rate by consumers to microtransit, the inefficiencies involved with empty vehicles between pickups, and the emissions rates of the microtransit vehicles themselves. The 3.8% figure, calculated for Montreal, was the more conservative of the two regions studied. The other value was 5% for Toronto.
- The 3.8% reduction in emissions is applied to the emissions anticipated under a BAU scenario that also includes some reductions in vehicle emissions due to expected increases in adoption of electric vehicles that will likely occur without any County actions.

Action 3: Expand and improve sidewalks, crosswalks, pathways and bike lanes and connect them to jobs, shopping, schools, and recreational amenities.

Methodology

An outcome-based approach was used to model walkable path and bike lane networks. Baseline tailpipe emissions for all types of passenger vehicles were calculated through 2045. This total was discounted by 2% per year by 2030 and 4% per year by 2045. This was to account for the reduction in VMT and associated tailpipe emissions from all passenger vehicle types that result from the increase in pedestrian infrastructure in the County.

Although these emissions reductions may be a bit high because the modeling is not based directly on emission reductions from sidewalks, paths, and bike lanes, several of the actions that are intended to reduce VMT were not modeled and therefore have no emissions reduction numbers assigned to them. Therefore, having an action where emissions reduction estimates may be slightly high can make up for the actions under T2 that do not have modeled reductions assigned to them.

Key Assumptions

- 2% passenger VMT reduction by 2030 and 4% passenger VMT reduction by 2045, which is consistent with other analyses conducted by ICF in the metropolitan Washington, D.C. region on increased land use density. These VMT

reductions found from increased land use density were then applied as a proxy for VMT reductions that may result from increased biking and walking infrastructure in Howard County.

– The reductions in emissions from the assumed reductions in VMT listed above is applied to the emissions anticipated under a BAU scenario. The BAU scenario includes some reductions in vehicle emissions due to expected increases in adoption of electric vehicles that will likely occur without any County actions.

Action 4: Increase and normalize teleworking options for employees whenever possible.

Methodology

Estimates for growth in number of jobs by NAICS industry for Maryland, provided by the Maryland Department of Labor and Industry, was applied to the actual number of jobs by industry in Howard County from 2019. The actual number was obtained from Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data and extrapolated to 2030 and 2045.

The percentage of employees by NAICS industry that can telecommute was estimated by Dingle and Neimen 2020.[54] In this study, researchers assessed occupational surveys to determine which occupations within different industries were telework capable.

Dey et al. 2020[55] estimated pre-COVID-19 telecommute uptake by NAICS industry using two different surveys.

The Dingle and Neimen 2020 industry telework capable percentages were discounted by the Dey et al. pre-COVID-19 uptake percentages. The resulting "delta" percent was multiplied by the projected number of jobs by industry in the county to obtain total new telecommute capable jobs in the county on top of the baseline telecommute rates from before COVID-19.

Based on the sources above, we found that the percentage of Howard County employees in 2022 who telework at least one day per week is about 23% of the total workforce, or 38,000 people. Projections were made for number of employees teleworking in 2030 and 2045 based on projections for total workers in those years and on our goals of getting 40% of the total workforce telecommuting by 2030 (70,800 people) and the maximum, based on the percentage of all jobs that are telework-compatible, of 52% of the workforce (105,000 people) in 2045.

Next, average work trip length for Maryland was obtained from the Baltimore Metropolitan Council's Travel Demand Forecasting.[56] Additionally, passenger vehicle mode share, that is, the percent of commuters using personal vehicles for commuting on work trips, was obtained from the National Household Travel Survey (NHTS) 2017. The number of new remote workers was multiplied by the passenger vehicle mode share percentage and the average work trip distance to determine total maximum work VMT avoided. The average work trip distance for Howard County for all workers is 14.62 miles each way, or 29.24 miles round trip.

A 17.4% induced VMT discount can be determined from Zhu and Mason 2014,[57] who compared the VMT trends of telecommuters and non-telecommuters in the 2009 National Household Travel Survey. They showed a mean non-work trip VMT of 31.5 miles for non-telecommuters, 28.2 mile mean work trip VMT for non-telecommuters, and a 36.4 non-work trip VMT for telecommuters. The total work VMT avoided in the previous step is discounted by 17.4%, calculated as

$$\frac{telecommuter\ mean\ non{\sim}work\ trip\ VMT - non{\sim}telecommuter\ mean\ non{\sim}work\ trip\ VMT}{non{\sim}telecommuter\ mean\ work\ trip\ VMT} = \frac{36.4 - 31.5}{28.2} = 17.4\%$$

Thus, for every 28.2 miles of work trip VMT avoided by a previously non-telecommuter beginning to telecommute, 4.9 miles of non-work trip VMT are added. This reflects additional VMT added when a worker is not commuting to the office. 4.9 miles divided by 28.2 miles is 17.4%. This percentage is subtracted from the VMT reductions achieved by telework. We

applied the 17.4% discount to the 29.24 mile average round trip commute for Howard County and to determine the VMT avoided each day by Howard County commuters teleworking is 24.15 miles (29.24 x 0.174 = 5.09 miles; 29.24 – 5.09 = 24.15).

Hybrid work schedules are likely to be the reality in coming years instead of pure work from home schedule. Reducing VMT is critical to lowering GHG emissions in Howard County, with transportation as the largest source of emissions. Therefore, our goal is for all employees with telework capable jobs (about 52% of total County workforce) to telework 3 days per week by 2045. We multiplied the total number of workdays per year of 260 by 3/5 to reflect 3 days spent at home and 2 days in the office). This results in 156 work days per year spent at home.

Daily VMT avoided by telework of 24.15 miles is multiplied by 156 days per year and then multiplied by the number of Howard County workers with telework capable jobs in each of our target years of 2030 and 2045. Although we show a baseline of 38,000 people telecommuting in 2022, we are assuming no reductions for teleworking from VMT emissions calculated for our GHG emissions reduction baseline year of 2005 because teleworking was rare at that time.

Expected VMT avoided in 2030 is 266.7 million VMT and in 2045 is 395.6 million VMT.

The resulting VMT reduction is converted to GHG emissions by using baseline ICE (internal combustion engine) emissions rates and EV efficiencies and uptake in future years. The resulting emissions reductions from reduced VMT is 90,600 MTCO2e in 2030 and 124,049 MTCO2e in 2045.

Key Assumptions

- Teleworking is available to all workers in the county (government and public) whose occupation is telework capable
- Share of telework capable jobs by industry was developed by Dingle & Neimen 2020
- Job total projections by industry for 2030 and 2050 are based on a constant average annual rate of change calculated from the 2020-2030 Maryland Department of Labor and Industry statewide projections[58]
- Starting jobs by industry in Howard County obtained from 2019 LEHD/LODES data[59]
- Average commute mileage for Howard County workers came from Baltimore Metropolitan Council's Travel Demand Forecasting.[60]
- A discount of 17.4% induced VMT was applied to telecommute miles to simulate increased VMT at home (Zhu & Mason 2014)
- Pre-COVID-19 telecommute uptake by industry was assumed and applied as a discount in the calculations (Dey et al. 2020)
- Hybrid work environment was simulated by assuming 2 days in the office per week, with 3 days at home.
- Discounted benefits by a baseline uptake of EVs in future years, as EVs will produce fewer emissions than ICE vehicles so the reductions in emissions between commuting with EVs and teleworking will be less than they would be for ICE vehicles.

Action 5: Implement policies, outreach programs, and incentives to promote individual behavior changes to reduce emissions from personal vehicles.

This action was not independently modeled.

Waste Strategies

Strategy W1: Reduce Organic Waste Sent to Landfills and Manage Landfill Methane (all actions)

Methodology

This action increases the number of households participating in the Green Bin program each year, diverting organic waste from landfilling to composting operations, which results in a net GHG reduction. A Howard County website references a waste study that indicated that approximately 30% of waste in the County is composed of organic material, which could be diverted from landfills.[61] This action focuses on residential organic waste, for which an existing composting program is available. Commercial organic waste could be another way to expand the impact of this action.

The number of new households participating in the program was multiplied by the average compost produced per household to estimate additional quantities of organic waste composted instead of landfilled.

Key Assumptions

- Approximately 15,000 people and 5,800 households are estimated to currently participate in the program[62]
- Current participation results in approximately 1,200 tons of compost diverted from landfills, which is about 0.2 tons per participating household
- The number of households participating in the program is increased by 5% per year under this action
- This amount of organic waste was reduced from in-County landfilling quantities and increased baseline composting quantities. To estimate the associated GHG savings, the same emission factors used for the GHG inventory (from the ClearPath software) were used, which include direct CH_4 and N_2O emissions associated with each waste management practice from EPA's Waste Reduction Model (WARM).)

Additional Strategies Estimated but Not Included in Formal Modeling

Land Use Potential

Methodology 1

This action reviewed how changes in land use could impact GHG emissions. Two specific changes to land use were reviewed: One to review how the tree canopy could be expanded, the other estimated how changes to agricultural practices (specifically no till farming) could change soil carbon. These analyses were done to provide the rough potential for emissions reductions or carbon storage for these two strategies and relied on multiplying potential land use acreage changes with the change in carbon (from either new tree canopy or new no till farming practices on land). Based on this preliminary analysis, the County could reduce approximately 162,000 $MTCO_2e$ through sequestration and improved practices.

Key Assumptions

- Existing Tree Canopy and potential tree canopy acreage values were derived from 2018 Howard County Tree Canopy Report. The possible tree canopy acreage value (excluding any agricultural uses) was considered as the potential land area for new tree canopy

- Total Existing Agricultural Land and Potential No Till Agricultural Land were derived from 2018 Howard County Tree Canopy Report. Potential Tree Canopy from Agricultural Land acreage value was considered as the Potential No Till Agricultural Land
- Net and Gross Tree carbon sequestration rates were used from a relevant study [63]
- Conventional Tillage and No Till Carbon Dioxide and Nitrous Oxide values were used from a relevant study[64]
- Changes in land use were phased in from 2023 through 2045 using a straight growth rate

Methodology 2

Howard County used the carbon storage estimate found through Methodology 2 because it is more specific to Howard County conditions. This methodology looks only at the carbon sequestration potential of forests and other trees that are outside of forests. Forests and urban trees sequester carbon from the atmosphere, while the conversion of forests to other land uses results in a net carbon release.

Initial investigations begun by the Office of Community Sustainability in 2022 suggest that the County's forested lands and tree canopy removed an estimated net 252,960 MTCO2e (metric tons of carbon dioxide equivalent) from the atmosphere per year. This number was generated using the International Council for Local Environmental Initiatives' Land Emissions and Removals Navigator, or "LEARN Tool," an online application designed to help local governments quantify the carbon stocks of their forests and trees outside of forests.[65] Changes from forest to other land use, and other canopy loss emitted an estimated 26,263 MTCO2e, which was accounted for and subtracted from a larger carbon sequestration estimate, to provide the net 252,960 MTCO2e figure. While the estimate provided with this tool notes that the MTCO2e values may be up to 45% greater or less in reality than indicated through the model, the model can reliably indicate the directionality of sequestration over time; that is, whether the forested and treed parts of the landscape are increasing or decreasing their carbon stocks and sequestration ability. In addition, Howard County used the GHG emissions sequestered by forests and urban trees to represent all carbon sequestration potential of natural and working lands in the County. Therefore, if the estimate for carbon storage potential of forests and trees alone is higher than the reality, other lands such as farms, native plant meadows, wetlands, etc. likely make up the difference.

Refrigerant Emission Changes (AIM Act)

Methodology

This action reviewed how changes in refrigerant types over time could reduce greenhouse gas emissions. It was modeled based on the recently passed federal AIM Act which directs the EPA to address HFC pollutants (which are many of the common refrigerants). Modeling was completed before regulations were provided and estimated drawdown of HFCs was largely modeled based on values from the Kigali Amendment (an international amendment to the Montreal Protocol from which the AIM act was based on). This was included as part of the enhanced modeling methodology. This could achieve emission reductions of approximately 96,000 $MTCO_2e$ in 2045.

Key Assumptions

- 20-year stock turnover
- The AIM Act will require an 85% phasedown of HFC production and consumption from a set baseline over 15 years (by 2036), starting in 2025
- Model assumes that the drawdown will follow the Kigali Amendment schedule (35% reduction by 2025, 70% in 2029, 80% in 2034, 85% in 2035)

- The AIM Act will require an 85% phasedown of HFC production and consumption from a set baseline over 15 years (by 2036), starting in 2025

- Model assumes that the drawdown will follow the Kigali Amendment schedule (35% reduction by 2025, 70% in 2029, 80% in 2034, 85% in 2035)
- No change in refrigerant use
- 5% of HFC using equipment turnover annually with new equipment lowering emissions along the set schedule
- Provides for an 82.5% reduction in total emissions from HFCs by 2050 given the 20-year life of equipment (total of turnover from previous 20 years)

[1] National Renewable Energy Laboratory (NREL). MD Cost -Effective Energy Efficiency Potential, NREL ResStock: https://resstock.nrel.gov/factsheets/MD

[2] EmPOWER Maryland 2018 & 2019 Annual Reports, BG&E

[3] Srivastava, R., and J. Mah. 2022. Moving the Needle on Comprehensive Commercial Retrofits. Washington, DC: American Council for an Energy-Efficient Economy. aceee.org/research-report/b2203.

[4] Lawrence Berkeley National Laboratory (LBL). Home Energy Saver. https://homeenergysaver.lbl.gov/consumer/

[5] ICF Analysis of regional costs (Based on Case Studies - Building Energy Performance Standards Development – Technical Analysis. Montgomery County, Maryland) https://www.montgomerycountymd.gov/green/Resources/Files/energy/Case%20Studies%20-%20Building%20Energy%20Performance%20Standards%20Report.pdf

[6] Energy Information Administration (IEA). Maryland Price of Natural Gas Delivered to Residential Customers. https://www.eia.gov/dnav/ng/hist/n3010md3m.htm

[7] Completed Commercial Permits, Howard County Permitting, 2006-2022

[8] Maryland Commission on Climate Change. Building Energy Transition Plan: A Roadmap for Decarbonizing the Residential and Commercial Building Sectors in Maryland. 2021. https://mde.maryland.gov/programs/air/ClimateChange/MCCC/Commission/Building%20Energy%20Transition%20Plan%20-%20MCCC%20approved.pdf

[9] National Renewable Energy Laboratory (NREL). National Residential Efficiency Measures Database. Retrofit Measures for Air Source Heat Pump. https://remdb.nrel.gov/

[10] Nadel, S., and C. Perry. 2020. Electrifying Space Heating in Existing Commercial Buildings: Opportunities and Challenges. Washington, DC: American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/pdfs/b2004.pdf

[11] National Renewable Energy Laboratory (NREL). National Residential Efficiency Measures Database. Retrofit Measures for Air Source Heat Pump. https://remdb.nrel.gov/

[12] ICF Analysis of regional costs (Based on Case Studies - Building Energy Performance Standards Development – Technical Analysis. Montgomery County, Maryland). https://www.montgomerycountymd.gov/green/Resources/Files/energy/Case%20Studies%20-%20Building%20Energy%20Performance%20Standards%20Report.pdf

[13] Energy Information Administration (IEA). Maryland Price of Natural Gas Delivered to Residential Customers. https://www.eia.gov/dnav/ng/hist/n3010md3m.htm

[14] Johns Hopkins Center for a Livable Future. Maryland Food System Map.https://gis.mdfoodsystemmap.org/map/#x=-8563005.033381129&y=4740926.687364919&z=9&ll=2,595,3

[15] Environmental Protection Agency - GreenChill. Profile of an Average U.S. Supermarket's Greenhouse Gas Impacts from Refrigeration Leaks Compared to Electricity Consumption. https://www.epa.gov/sites/default/files/documents/gc_averagestoreprofile_final_june_2011_revised_1.pdf

[16] National Association of Convenience Stores (NACS). What is a Convenience Store? https://www.convenience.org/Research/What-is-a-Convenience-Store

[17] Duffy, Steven. Small Formats' Big Future in Retail. *Progressive Grocer*. https://progressivegrocer.com/small-formats-big-future-retail

[18] Environmental Protection Agency (EPA) - GreenChill. About the GreenChill Corporate Emissions Reduction Program. https://www.epa.gov/greenchill/about-greenchill-corporate-emissions-reduction-program

[19] Environmental Protection Agency (EPA) - GreenChill. GreenChill Store Certification Program. https://www.epa.gov/sites/default/files/2020-11/documents/gc_storecertprogram_11.12.20.pdf

[20] Environmental Protection Agency (EPA) - GreenChill. GreenChill Certified Stores. https://www.epa.gov/greenchill/greenchill-certified-stores

[21] ICF Energy Codes Tool, PNNL Energy Code Savings tab

[22] Salcido, VR, Y Chen, Y Xie, and ZT Taylor. National Cost-Effectiveness of the Residential Provisions of the 2021 IECC. PNNL-31019, Pacific Northwest National Laboratory, June 2021. , Table 11: Total Construction Cost Increase for the 2021 IECC Compared to the 2018 IECC. https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf

[23] Tyler, M, R Hart, Y Xie, MI Rosenberg, MA Myer, MA Halverson, C Antonopoulos, and J Zhang. National Cost-Effectiveness of ANSI/ASHRAE/IES Standard 90.1-2019 PNNL-29940, Pacific Northwest National Laboratory, July 2021. Table 4.8: Incremental Initial Construction Costs. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-29940.pdf

[24] Energy Information Administration (IEA). Maryland Price of Natural Gas Delivered to Residential Customers. https://www.eia.gov/dnav/ng/hist/n3010md3m.htm

[25] Maryland Commission on Climate Change. Building Energy Transition Plan: A Roadmap for Decarbonizing the Residential and Commercial Building Sectors in Maryland. 2021. https://mde.maryland.gov/programs/air/ClimateChange/MCCC/Commission/Building%20Energy%20Transition%20Plan%20-%20MCCC%20approved.pdf

[26] ICF Energy Codes Tool, PNNL Energy Code Savings tab

[27] National Renewable Energy Laboratory (NREL). National Residential Efficiency Measures Database. Retrofit Measures for Air Source Heat Pump. https://remdb.nrel.gov/

[28] Nadel, S., and C. Perry. 2020. Electrifying Space Heating in Existing Commercial Buildings: Opportunities and Challenges. Washington, DC: American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/pdfs/b2004.pdf

[29] Salcido, VR, Y Chen, Y Xie, and ZT Taylor. National Cost-Effectiveness of the Residential Provisions of the 2021 IECC. PNNL-31019, Pacific Northwest National Laboratory, June 2021. Table 11: Total Construction Cost Increase for the 2021 IECC Compared to the 2018 IECC. https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf

[30] Tyler, M, R Hart, Y Xie, MI Rosenberg, MA Myer, MA Halverson, C Antonopoulos, and J Zhang. National Cost-Effectiveness of ANSI/ASHRAE/IES Standard 90.1-2019 PNNL-29940, Pacific Northwest National Laboratory, July 2021. Table 4.8: Incremental Initial Construction Costs. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-29940.pdf

[31] Energy Information Administration (IEA). Maryland Price of Natural Gas Delivered to Residential Customers. https://www.eia.gov/dnav/ng/hist/n3010md3m.htm

[32] Environmental Protection Agency (EPA). The Emissions & Generation Resource Integrated Database (eGRID). https://www.epa.gov/egrid

[33] Energy Information Administration (EIA). Annual Energy Outlook 2022. https://www.eia.gov/outlooks/aeo/

[34] Project Sunroof data explorer (June 2019). Howard County technical potential https://sunroof.withgoogle.com/data-explorer/place/ChIJH5jhq5AmyIkRktjkA__Uilo/

[35] Project Sunroof data explorer: a description of methodology and inputs https://sunroof.withgoogle.com/assets/data-explorer-methodology.pdf

[36] Howard County Permitting, Completed and Issued Permits

[37] National Renewable Energy Laboratory (NREL). PVWatt Calculator https://pvwatts.nrel.gov/pvwatts.php

[38] Adapted from NREL ATB 2022 (CAPEX from Resource Class 7- Moderate 2020-2030 average cost)- https://atb.nrel.gov/electricity/2022/data

39 Javid, Roxana J., Mahmoud Salari, and Ramina Jahanbakhsh Javid. Environmental and Economic Impacts of Expanding Electric Vehicle Public Charging Infrastructure in California's Counties. *Transportation Research Part D: Transport and Environment* 77 (December 2019): 320–34. https://doi.org/10.1016/j.trd.2019.10.017.

[40] Electrification Futures Study: A Technical Evaluation of the Impacts of an Electrified U.S. Energy System | Energy Analysis | NREL

[41] Javid, Roxana J., Mahmoud Salari, and Ramina Jahanbakhsh Javid. Environmental and Economic Impacts of Expanding Electric Vehicle Public Charging Infrastructure in California's Counties. *Transportation Research Part D: Transport and Environment* 77 (December 2019): 320–34. https://doi.org/10.1016/j.trd.2019.10.017.

[42] Howard County Department of Planning and Zoning, Research Division. Howard County Demographic Overview. 2020. https://www.howardcountymd.gov/sites/default/files/media/2020-10/Howard%20County%20Demographic%20Overview%20-%202020.pdf

[43] U.S. Census population estimates (Vintage 2021)
[44] Maryland Statewide Household Travel Survey Final Report. August 2020. https://baltometro.org/sites/default/files/bmc_documents/data%26maps/transportation/maryland-travel-survey/200902_MTS_FinalReport.pdf
[45] Used Javid et al. 2019 average value because the structure of this variable was not well defined
[46] U.S. Census population estimates (Vintage 2021)
[47] AAA. Gas Prices. https://gasprices.aaa.com/?state=MD
[48] Bureau of Labor Statistics (BLS). News Release. Average Energy Prices, Baltimore-Columbia-Towson – November 2020. Released: December 14, 2020. https://www.bls.gov/regions/mid-atlantic/news-release/2020/pdf/averageenergyprices_baltimore_20201214.pdf
[49] Booth, David. (2022, February 18). Motor Mouth: How many EV charging stations will we really need? *Driving*. https://driving.ca/column/motor-mouth/motor-mouth-how-many-ev-charging-stations-will-we-really-need
[50] Argonne National Laboratory (ANL). Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool. https://greet.es.anl.gov/afleet_tool
[51] Argonne National Laboratory (ANL). Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool. https://greet.es.anl.gov/afleet_tool
[52] Department of Energy. Alternative Fuels Data Center. Average Fuel Economy by Major vehicle Category. February 2020. https://afdc.energy.gov/data/10310
[53] MaRS Discovery District, The Atmospheric Fund, and Coop Carbone. Microtransit: An Assessment of Potential to Drive Greenhouse Gas Reductions. 2016. https://www.marsdd.com/wp-content/uploads/2016/12/Microtransit-report-2016.pdf.
54 Dingel, Jonathan I., and Brent Neiman. How Many Jobs Can Be Done at Home? *Journal of Public Economics* 189 (September 2020): 104235. https://doi.org/10.1016/j.jpubeco.2020.104235.
55 Dey, Matthew, Harley Frazis, Mark A. Loewenstein, and Hugette Sun. Ability to Work from Home: Evidence from Two Surveys and Implications for the Labor Market in the COVID-19 Pandemic.: *Monthly Labor Review: U.S. Bureau of Labor Statistics*. June 2020.
56 Travel Demand Forecasting | Baltimore Metropolitan Council (baltometro.org)
57 Zhu, P., and S. G. Mason. The Impact of Telecommuting on Personal Vehicle Usage and Environmental Sustainability. *International Journal of Environmental Science and Technology* 11, no. 8 (November 2014): 2185–2200. https://doi.org/10.1007/s13762-014-0556-5.
[58] https://www.dllr.state.md.us/lmi/iandoproj/
[59] U.S. Census Bureau. Longitudinal Employer-Household Dynamics. https://lehd.ces.census.gov/data/
60 Travel Demand Forecasting | Baltimore Metropolitan Council (baltometro.org)
61 Bureau of Environmental Services, Howard County Maryland. Feed The Green Bin. https://www.howardcountymd.gov/public-works/feed-green-bin
[62] Bureau of Environmental Services, Howard County Maryland. Feed The Green Bin. https://www.howardcountymd.gov/public-works/feed-green-bin
[63] Nowak, D. J., Greenfield, E. J., Hoehn, R. E., & Lapoint, E. (2013). Carbon storage and sequestration by trees in urban and community areas of the United States. Environmental Pollution, 178, 229-236. https://www.sciencedirect.com/science/article/pii/S0269749113001383
[64] Swan, Amy, SA Williams, K Brown, A Chambers, J Creque, J Wick, K Paustian. COMET-Planner: Carbon and greenhouse gas evaluation for NRCS conservation practice planning. http://bfuels.nrel.colostate.edu/beta/COMET-Planner_Report_V1Legacy.pdf
65 Land Emissions and Removals Navigator, ICLEI Land Emissions and Removals Navigator | ICLEI USA

Appendix G: Current Howard County Climate Initiatives

Energy Conservation and Energy Efficiency

Building Codes

As of January 11, 2019, new home construction in Howard County is required to be "EV-Ready," meaning that it must include infrastructure for plug-in electric vehicles. Installing EV infrastructure during construction is much more cost-effective than adding wiring later. Howard County is the first jurisdiction in Maryland and one of the first in the U.S. to require that new residential construction with driveways or garages have the electric wiring to enable electric vehicle charging. Even more innovative, new multi-family residential building will be required to provide one EV charging station for every twenty-five residential units.

Implementing targeted building code updates can be beneficial to the community in Howard County because those updates can improve long-term building resiliency in a changing climate. Increasing the number of targeted building code updates can help to reduce the number of heat islands by using reflective building materials and including more shade plantings and other heat mitigation measures on site.

Due to Howard County's Department of Inspections, Licenses and Permits staff being active participants in several International Code Council committees and workgroups, the staff are constantly working to revise and update building codes that will not only protect property but also people. As of 2022, Howard County has adopted all of the modern international building codes, with the exception of the International Green Construction Code overlay. https://www.howardcountymd.gov/inspections-licenses-permits/adopted-codes

Energy Performance Contracts

In 2009, Howard County's EPC energy upgrades in seven County facilities resulted in $238,000 of annual energy savings. In 2015, Howard County's follow-on EPC efforts included energy audits at all 200-plus County-owned facilities and proposed energy conservation measures in 67 buildings. The installation of the measures in all buildings was completed in 2018 and the energy performance contract guarantees $900,000 in annual cost savings.

Energy Conservation and Efficiency Education

Howard County provides information to the public on how to save energy and how access rebates, incentives and technical assistance, and use the most energy efficient equipment at work and at home.

LED Light Bulb Exchanges

Howard County offers residents free LED light bulbs at light bulb exchange events at Greenfest, 50+ Centers, and Community Centers. In 2023, Howard County began a partnership with the Howard County Public Library System. Through this program, residents can exchange their old, inefficient bulbs for new LED bulbs at the Elkridge Branch and East Columbia Branch circulation desks.

LEED Certified Buildings

New publicly funding buildings which consists of 30% or more County funding and are larger than 10,000 square feet must attain a LEED Silver rating. Most new private buildings larger than 50,000 square feet must attain a LEED Certified rating.

Howard County provides tax credits for these high-performance buildings. These commercial and residential buildings that qualify will receive tax credits when the buildings are fully built to the certain LEED and equivalent standards.

LEED for Cities and Communities

In August 2022, Howard County became the first county in the U.S. to obtain the LEED Platinum certification in the current Cities and Communities Program.

Little Patuxent Water Reclamation Plant

Howard County's Water Reclamation Plant uses a state-of-the-art technology Enhanced Nutrient Removal system to make it more energy efficient and reduce the amount of nitrogen that is released into the environment. There are two backup generators at this plant that protect the plant from power loss. Additionally, the plant has installed a solar energy array to completely offset the carbon of the generators and partially offset the carbon emissions of the plant.

Planning and Zoning

Howard County is planning to incorporate climate action throughout the new general plan, HoCo By Design, which is expected to be completed in 2023. This new General Plan will set the vision for the County's future growth, development and conservation policies over the next 20 years and reflect the shift in demographics and changes to the communities' priorities and goals. https://www.hocobydesign.com/

Green Neighborhoods: The Green Neighborhoods program is a voluntary program that uses housing allocations as an incentive to encourage development that conserves and protects natural resources, while providing sustainable communities that are energy and water efficient. The Green Neighborhoods Program consists of a Sites and a Home's component.

Watershed Planning: Watershed planning provides steps and feedback so environmental planning is better coordinated throughout the County. Watershed planning and management includes all of the activities related to preserving, protecting and restoring the streams, wetlands, forests and other natural resources that can be found in a watershed.

Retro commissioning

Howard County has received grants and rebates to "retro commission" seven buildings. Retro commissioning involves building tune-ups that will maximize energy efficiency and cost savings. The building tune-ups include making sure heating and cooling systems are working and are calibrated and programmed correctly. As of 2022, retro commissioning has been completed at the East Columbia Library, Ellicott City Senior Center, North Laurel Community Center, Gateway Building, Glenwood Public Library, Scaggsville Public Safety Complex, and the Charles E. Miller Library. Howard County is planning additional retro commissioning in 2023 at the George Howard Building, Warfield Building, and Carroll/Ligon Buildings in Ellicott City. On average, retro commissioning reduces building energy use by about 10 percent.

Street Light Conversion Program

As of July 2022, Howard County has converted all streetlights to LED (10,000 streetlights). This conversion resulted in a reduction of electricity use by over 225,000 kWh per year and a reduction of GHG emissions by 3,045 metric tons CO_2e.

Weatherization for Underserved Populations

Howard County promotes the nonprofit Community Action Council's (CAC) Weatherization Assistance Program, which permanently reduces energy bills by making the home more energy efficient. Funds for this work comes from federal and state energy efficiency grants. https://cac-hc.org/weatherization-assistance/

Renewable Energy

Solar Education and Outreach

Howard County and its partners educate residents and businesses about how to go solar through websites, social media, events, and newsletters. Howard County also hosts and promotes residential solar and community solar workshops both in person and online. https://livegreenhoward.com/energy/renewable-energy/

Solar Power Purchase Agreement (PPA)

In 2020, the County signed a Power Purchase Agreement (PPA) to install solar on County-owned and privately-owned sites. These solar projects will power more than 50 percent of County operations and result in more than $1.5 million in cost benefits over 25 years, with no up-front capital costs to the County. The combined projects will generate a monumental 44 million kilowatt hours of electricity each year from solar on rooftops, canopies over parking lots, and ground mounts on County and private properties. Ground mount solar arrays on private properties will showcase innovative practices such as pollinator plantings around the panels as well as sheep-grazing and beekeeping. https://livegreenhoward.com/howard-county-solar-projects/

Solar Zoning Regulation Amendment

Council Bill (CB) 17-2021, passed in May 2021, was transformative legislation that expanded solar opportunities in the County to all zones including on agriculturally preserved land. The bill also requires that ground mount solar facilities on Agricultural Land Preservation Program (ALPP) properties provide pollinator or native grass habitats, grazing for livestock, or other ecologically enhancing alternative under the solar array.

Transportation

Bus/Transportation Routes

Howard County provides fixed route and paratransit services via the Regional Transit Agency (RTA), which operates 15 local fixed bus routes in Howard County, Prince George's County, Anne Arundel County, and the City of Laurel. RTA connects with MTA Commuter Bus services, the MARC Train, Metrorail, and other local transit systems. RTA Mobility is a curb-to-curb, shared ride transportation service for passengers who are unable to ride fixed route buses due to a disability or age.

Howard County offers unlimited free rides on its fixed bus routes for people ages 60 and up, and reduced rates for students. https://www.howardcountymd.gov/transportation/public-transportation

Complete Streets

Howard County adopted a Complete Streets Policy in 2019 establishing safety and access for all modes as the priorities for our streets. The Howard County Complete Streets Design Manual was adopted in 2022 as technical design guidance to implement the Complete Streets Policy.

Electric Scooter Pilot

The Howard County Office of Transportation oversees the permitting process for shared electric scooters. One vendor, SPIN, was granted a permit to operate up to 200 shared electric scooters in Howard County from March 23, 2022 to March 22, 2023. At the end of the pilot, adjustments to the permit requirements will be considered and advertising will begin for applications for 2023 permitting.

Electric Buses

Howard County received a federal grant to add three full-size, lightweight electric buses to the Howard Transit fleet for use in and around Columbia. These new buses are powered by an inductive charger that provides energy to the bus batteries through electromagnetic induction. In other words, the batteries are reenergized without having to be plugged in. The buses operate on Howard Transit's Green Route which is the most heavily used line.

EV Charging Stations

Howard County has dramatically increased the number of EV charging stations available to the public through a variety of partnerships, which include BGE, Maryland Energy Administration, and private businesses. There are several Apps people can use to find the EV charging stations, such as Liberty Plugins and PlugShare. https://livegreenhoward.com/electric-vehicles/

Green Fleet

Howard County has implemented a Green Fleet policy that includes reducing unnecessary idling, limiting the use of take-home vehicles, and replacing older petroleum-fuel administrative vehicles with electric vehicles. Other petroleum-only vehicles are replaced with hybrids when due for replacement when that option exists. The goal of the Green Fleet Policy is to reduce petroleum fuel consumption in the fleet by 20% by 2024. To date, Howard County has eight electric vehicles, six electric motorcycles, and 177 hybrid vehicles. Howard County has partnered with the Maryland Energy Administration to receive grants towards several of these electric vehicles. Howard County also incorporated two diesel-electric hybrid buses into the Howard Transit service. These hybrid buses reduce fuel consumption by about 35% and reduce maintenance and repair costs compared to similar diesel buses.

Transportation Planning

Bike Howard

BikeHoward is the Howard County Bicycle Master Plan. Adopted in 2016, BikeHoward includes recommendations for infrastructure improvements that create a network on bike friendly routes throughout Howard County. https://bikehoward.com/

Walk Howard

The *WalkHoward* plan is an update of the 2007 Pedestrian Master Plan. The new Pedestrian Plan that was adopted in 2020, *WalkHoward*: Moving Forward, continues efforts to improve walkability in Howard County. This new plan includes recommendations for infrastructure improvements, with a focus on access to transit and school zones. Our community is happier, healthier, safer and more efficient when we have a system of sidewalks, pathways, bus stops and roadway crossings that make it easy to get around on two feet and in a wheelchair. https://walkhoward.org/

Go Howard

Go Howard is the county's Transportation Demand Management (TDM) program. TDM refers to a group of strategies used to manage the demand for travel to create the most efficient use of our existing roadways. These strategies encourage people to utilize alternatives to the single-occupancy vehicle (SOV) such as transit, rideshare, walk, bike, and telework, thereby reducing the number of vehicles using the road network. https://gohoward.org/

Stormwater

Stormwater Regulations and Permits

Howard County follows Maryland Department of the Environment (MDE) most current regulations and strives to meet or exceed our Municipal Separate Storm Sewer System (MS4) permit requirements. Howard County collaborates with regional jurisdictions and other permit holders as well as MDE to explore opportunities and innovation in stormwater management.

Stormwater Management Facilities and Departments

Stormwater management crosses many departments throughout Howard County. Howard County Department of Public Works implements stormwater management largely on public property while Office of Community Sustainability focuses on private partnerships to increase stormwater treatment. Department of Planning and Zoning works to ensure stormwater regulations are followed for new and redevelopment.

CleanScapes Program

The CleanScapes Program provides funding to residential property owners who aid the County in meeting water quality goals by installing stormwater best management practices (BMPs), such as rain gardens, on their properties. Residents can receive a one-time reimbursement for the cost of installing a stormwater BMP, as well as an annual credit towards their Watershed Protection Fee. In addition, an opportunity for a 100% reimbursement of BMP costs is available to residents demonstrating a hardship.

Ellicott City Safe and Sound

The Ellicott City Safe and Sound plan is a multi-phase plan built around the need for public safety, supporting business and property owners, preparing the county for a changing climate, and creating a more inclusive, community driven process for decisions regarding Ellicott City's future. There are four main focus areas of the plan: ensuring public safety, supporting business and property owners, maintaining Ellicott City's historic charm, and developing a more inclusive, community-driven process. https://www.ecsafeandsound.org/

Innovative Stormwater Management

Howard County continually looks to innovate practices and partnerships to further our stormwater management and meet permit regulations. Utilizing public private partnerships and alternative funding strategies, the County successfully implemented both water quality and quantity treatment with the commercial and agricultural sectors.

Nature-Based Climate Solutions

Bee City

In 2019, County Executive Ball named Howard County a Bee City USA. The Bee City Committee works to implement new pollinator habitat areas, provide outreach, design pollinator garden templates for public use, and give away plants to promote pollinator gardening at home.

Forest Conservation Act

On December 6, 2019 Howard County Executive Calvin Ball signed the updated and improved Howard County Forest Conservation Act (FCA), which had not been updated since the 1990s. This brought Howard County into compliance with the Maryland Forest Conservation Act and made our County's FCA the strongest of any county in Maryland. The update strives to protect forest resources in every neighborhood by requiring 75% of tree planting obligations generated through the residential development process to be planted on the development site. The updated FCA also incentivizes meeting planting obligations in the watershed where development occurs, further protecting trees throughout the County. The updated FCA also raised the fee-in-lieu of planting by over 50%, strengthened the waiver process by requiring additional justification and proof of alternatives considered, and included the Green Infrastructure Network as a priority planting and retention area.

Green Infrastructure Network (GIN)

Maps the most ecologically valuable forests, wetlands, meadows, waterways, and other natural areas as well as the lands that connect them together. Green Infrastructure helps support native plant and animal species while helping human populations by cleaning air and water resources, maintaining natural ecological processes, and contributing to everyday quality of life. The GIN provides six (although there are more) ecosystem services: recreation, pollination, air purification, flood control, water treatment, and pest control. The use of hubs and corridors is important for a green infrastructure network and fit together to create a successful GIN for Howard County. Howard County's Green Infrastructure Network Plan (GIN Plan) refines and expands on the State of Maryland's Green Infrastructure Network to include areas of local ecological significance. The GI Plan will enable planners to consider important resources when preparing the General Plan, transportation plans, watershed plans, and community plans; making decisions about zoning and development proposals; acquiring land for parks and public facilities; and obtaining agricultural, environmental, and other land preservation easements. https://livegreenhoward.com/land/green-infrastructure-network/

Meadows on County Properties

Howard County plants and maintains native plant meadows in its parks and natural areas to provide habitat for pollinators and ground nesting birds, as well as to showcase the beauty of these low-maintenance natural habitats. Howard County's Department of Recreation and Parks maintains well over 30 acres of meadows across the county.

No Mow Areas

Howard County is studying alternative lawn mimics and pollinator plantings in collaboration with Columbia Association and the University of MD. The research includes a variety of sites for the alternative lawn trials and is studying which seed mixes provide the most weed resistance, least maintenance, greatest drought tolerance, and most aesthetic match to lawns. Howard County expects the pollinator plot trials to reveal the best weed control strategy to use when installing pollinator gardens.

Pesticide Reduction

Howard County updated its Pesticide Policy in 2019, eliminating the use of chlorpyrifos and drastically restricting the use of glyphosate and neonicotinoids on County owned property. The policy stresses integrated pest management and alternative solutions.

Tree Planting Programs

Howard County offers free trees to residents through several tree giveaways, including Trees for Bees. Since 2019, Howard County has given away more than 10,000 trees to residents and local nonprofits. The trees are all native species, meaning that they are adapted to our climate and conditions. Native species generally live longer and require less care. They are also co-adapted with native pollinators, birds, and other wildlife.

Stream ReLeaf: The Stream ReLeaf program helps property owners plant riparian buffers. Riparian buffers are protective strips of trees, shrubs, and other vegetation along a stream which help prevent erosion, provide vegetative cover, and trap nutrients such as nitrogen and phosphorus – two major pollutants of the Chesapeake Bay.

Turf to Trees: The Turf to Trees program was created to help alleviate the damaging effects of stormwater runoff by increasing tree coverage throughout the County. The program provides trees and planting services to Howard County property owners with lots of 1.5 to 10 acres in size, free of cost. Since the project started in 2015, over 3,100 trees have been planted.

Students Branching Out: Students Branching Out engages Howard County students in local tree planting efforts. Students have participated in tree planting volunteer days and field trips, planted trees on school property, and promoted existing County tree planting programs. Over 6,500 trees have been planted with thousands of students so far.

Information on all tree programs can be found at https://livegreenhoward.com/land/tree-programs/.

Solid Waste & Recycling

Composting

The Bureau of Environmental Services operates a facility to compost food waste and yard waste. Seasonal yard waste curbside collection is available to all County residents. About half of County residents are currently eligible to participate in year-round curbside food waste and yard waste collection through the Feed the Green Bin program. Public schools also can participate in food waste collection by request. In addition, Howard County provides free backyard compost bins upon request and the Residents' Convenience Center at Alpha Ridge Landfill also accepts food scraps.
https://www.howardcountymd.gov/public-works/feed-green-bin

Plastics Reduction

Plastic bag fee: As of October 1, 2020, all stores in Howard County who provide customers a disposable plastic bag at the point of sale are required to charge 5 cents per bag. Businesses keep one cent from every fee and the remainder goes to funding the Plastics Reduction and Environmental Protection (PREP) grant program, providing reusable bags predominantly to vulnerable communities and for other environmental purposes. https://livegreenhoward.com/recycling-waste/plastic-bag-fee/

Single use plastics ban: As of January 1, 2022, food service facilities can longer sell or distribute single-use plastic straws, stirrers, utensils, condiment packets, and other food ware to customers unless specifically requested, with certain exceptions for self-service areas and drive through. Retail businesses cannot sell or distribute single use plastic straws or stirrers unless paper or reusable straws or stirrers are also available for purchase in the same location. https://livegreenhoward.com/plastic-reduction-law/

Plastics Reduction and Environmental Protection (PREP) Grants

Using funds from the plastic bag reduction fee, Howard County introduced the Plastics Reduction and Environmental Protection (PREP) grant. This grant program provides funding to local organizations working to reduce litter, improve water quality, and provide education to the public regarding pollution and our environment. The County received great interest in the first request for grant applications in 2021 from a wide variety of organizations with a diversity of project ideas. https://livegreenhoward.com/recycling-waste/plastic-bag-fee/prep-grants/

Recycling

Single Stream Recycling: Howard County residents with County-provided collection can place recyclables all together in the same container. Acceptable recyclables include metal cans, plastics, glass bottles and jars, mixed paper and cardboard. Waste Management Recycle America (WMRA) is under contract to Howard County for the processing and marketing of recyclables. WMRA operates a state-of-the-art recyclables processing facility near Elkridge, which has the necessary equipment to sort recyclables in preparation for sale to individual material markets. The Residents' Convenience Area at Alpha Ridge Landfill is a great resource for additional recycling opportunities for all Howard County Residents. Items ranging from scrap metal to reusable building materials to used cooking oil can be brought in for recycling. https://www.howardcountymd.gov/public-works/recycling

Howard County also provides a comprehensive online list of harder to recycle items with suggestions on how to properly recycle, donate, or reuse these items. https://www.howardcountymd.gov/knowbeforeyouthrow

Emergency Management

Emergency Management Plans

Howard County has a 2018 Natural Hazard Mitigation Plan which includes a Flood Mitigation Plan update. These plans suggest several actions to reduce or eliminate risk to people or property from future natural hazards. They include hazard mitigation, preparedness, emergency response, and recovery actions. These plans are reassessed and updated every five years in conjunction.

Additionally, Howard County has a Comprehensive Emergency Response and Recovery Plan (CERRP) which defines the responsibilities and roles of local, state, and federal entities during an emergency event for a coordinated response and recovery.

Other resources include the Community Hazard Handbook and the Hazard Identification & Risk Assessment (HIRA). https://www.howardcountymd.gov/emergency-management

Cooling Centers

There are several facilities people can utilize when they are in need of a place to cool off on a hot day. These include Howard County Library System Branches, Howard County 50+ Centers, Howard County Recreation & Parks Community Centers, and The Mall in Columbia.

Agriculture

Roving Radish

The Roving Radish is a Howard County Government program dedicated to promoting healthy farm to table eating habits to our community, while creating sustainable markets for our local and regional farms. We achieve this by selling healthy meal kits, sourced from local and regional farms to our community. The meal kits are made available to all Howard County residents and are offered at a discounted price to those in need. The Roving Radish also operates a store at Long Reach Village Center that offers meats, dairy projects, eggs, and fresh produce from local farms. https://rovingradish.com/

HoCo Fresh

HOCO Fresh is a Howard County Government program to encourage restaurants and businesses to buy produce and proteins from our Howard County Farms.

HOWARD Soil Conservation District (HSCD)

The HSCD has staff that are trained specialists who help landowners make the best land use decisions for their properties. There are cost sharing options through federal, state and/or local sources that may be available for conservation practices that control erosion and improve water quality.

The HSCD is solely authorized to review sediment and erosion control plants and small pond designs for all proposed developments. Their trained specialists and engineers actively participate on Howard County's weekly subdivision Review Committee with other state and county agencies.

Technical experts provide direct one-on-one assistance to homeowners, community associations and county departments with natural resource problems and questions.

HOWARD County Economic Development Authority (HCEDA)

HCEDA offers the Agricultural Marketing Program that works with the farming community as their constant advocate on agriculture-related legislation and business development. There are five main ways to delve into what this program does: Start A Farm, Diversify My Farm, Grants & Financing, Farms & Markets, and Fall Fun on The Farm. https://hceda.org/

Start A Farm offers tools for the farming community by providing information on licensing, permits, regulations, resources, and training & education. Diversify My Farm provides the farming community with options to expand on their options they provide to the public, such as Agri-Tourism, Solar or Wind Energy Collection, or Value-Added Processing. The Grants & Financing aspect allows the farming community to gather information about County Grants, State Loans & Grants, Regional Loans & Grants, and Federal Loans & Grants. The Farms & Markets part of the program offers two options for the farming community: Farm to Table and Farm Search. Lastly, the Fall Fun on The Farm offers a variety of different events occurring at farms throughout the Fall.