Attachment 1

Frederick County Climate and Energy Action Plan for Internal Government Operations

March 2023

DIVISION OF ENERGY AND ENVIRONMENT

Metropolitan Washington Council of Governments

This page intentionally left blank.

FREDERICK COUNTY GOVERNMENT

OFFICE OF THE COUNTY EXECUTIVE

Jessica Fitzwater
County Executive

Chelsea Kadish, Chief of Staff

Climate change is the defining challenge of our time, threatening our infrastructure, economic security, health and well-being, and ecological integrity. The increase in global temperatures, which is changing our weather patterns and our way of life, is impacted by human activity. This means we can, and should, take action to change course. Swift and sustained reductions in greenhouse gas emissions can lessen our impact and help us to mitigate the worst consequences of the climate crisis.

Frederick County is committed to doing our part. In 2020, the Frederick County Council adopted a Climate Emergency Resolution, which resolved to cut greenhouse gas emissions to half of 2010 levels no later than 2030 and reduce levels 100% by 2050. To guide the work, the Council established an independent volunteer-based Climate Emergency Mobilization Workgroup. The workgroup's Climate Response and Resilience Report (CRRR) offers recommendations based on the work of over 70 volunteers, who together invested 18,500 hours over the course of a year.

In response to the CRRR, the Division of Energy and Environment created this Climate and Energy Action Plan for Internal Government Operations. The plan assesses Frederick County Government's practices, policies, and assets. It also provides a way to build operational resiliency and reduce the climate impacts of our day-to-day work. I hope this document - and our actions - serve as a model and a resource as we collaborate on larger community endeavors, including those of the broader Metropolitan Washington region.

Working together, we can accelerate progress toward state, federal, and global goals to reduce emissions. The recommendations in this document take economics, equity, and the environment into consideration. This plan can save tax dollars, foster technological advances, ensure that our services meet the needs of vulnerable populations, and protect our infrastructure and natural assets.

The people in Frederick County can't stop the global climate crisis alone, but we can do our share to reduce greenhouse gases and make our community more resilient. Combating climate change is difficult, complex, and often overwhelming. How we respond defines us - and our future. Beyond providing a strategic plan, the Climate and Energy Action Plan is a source of optimism- showing that there are things we can do to make a difference, and we are determined to do them. Knowing that County agencies and employees are leading the way in countering climate threats gives me hope for the future. I encourage all of Frederick County to join us in this immensely important undertaking.

Jessica Fitzwater
Frederick County Executive

Acknowledgments

This report was produced by Frederick County Government (FCG) staff working in partnership with the Metropolitan Washington Council of Governments (MWCOG) and consultant ICF Incorporated, L.L.C. (ICF). MWCOG is an independent, nonprofit association that brings area leaders together to address major regional issues. ICF is nationally recognized for expertise in greenhouse gas accounting and mitigation planning, vulnerability and risk assessment, and climate resilience planning.

The Division of Energy and Environment thanks the many FCG agencies that collaborated on this effort. The diversity of disciplines, expertise, and experience shared by Frederick County employees had a significant impact on the creation of this plan. County Government partners included the following divisions:

- Citizen Services
- Economic Development Office
- Emergency Management
- Finance
- Fire and Rescue Services
- Health Services
- Interagency Information Technologies
- Parks and Recreation
- Planning and Permitting
- Public Works
- Senior Services
- Sheriff's Office
- Solid Waste and Recycling
- Transit Services
- Water and Sewer Utilities

Table of Contents

Frederick County Climate and Energy Action Plan for Internal Government Operations

Climate change is impacting communities across the globe and presenting governments with an uncharted challenge. Frederick County is already experiencing increasingly frequent and intense extreme weather events and other climate hazards, such as extreme heat, flooding, winter storms, and drought. Frederick County developed this Climate and Energy Action Plan (CEAP) to identify mitigation and adaptation opportunities within County government operations.

Frederick County has been a leader in addressing climate change since the early 2000s. The County developed its first greenhouse gas (GHG) inventory in 2007 and a comprehensive energy plan in 2010. More recently, in 2020, the County Council established the Climate Emergency Mobilization Workgroup to provide recommendations on climate strategies. In 2021, County Executive Jan Gardner and the County Council launched several climate initiatives. In addition, the 2022 update to the Frederick County Hazard Mitigation Plan included actions to reduce risk from climate hazards. In 2023, County Executive Jessica Fitzwater began implementing the CEAP.

This CEAP aligns with state and regional goals while building on the County's previous climate actions to provide a pathway to further reduce County GHG emissions and improve resiliency.

Objectives and Scope

This CEAP provides a roadmap for the County to reduce its contribution to climate change and prepare for a changing climate. The CEAP documents Frederick County Government's strategy to measure and reduce GHG emissions from County operations, and to identify and reduce climate risks. This CEAP focuses on County internal government operations and does not include GHG emissions or climate risks of the broader community, private sector, or households.

Primary Objectives of the CEAP

- Describe the County's baseline and projected GHG emissions through 2050, including a discussion of base year (2010) and progress year (2018) GHG emissions.
- Identify GHG reduction strategies and estimate their impact on climate targets.
- Assess the risks and vulnerabilities posed to County government operations and County-managed assets under a changing climate.
- Recommend operational strategies to improve County government resilience.
- Consider and incorporate the impact of parallel actions the County is taking, such as developing an Alternative Fuels Vehicle Plan.
- Provide key next steps and guidance to help the County implement the strategies in this Plan and track progress towards goals over time.

Greenhouse Gas Inventory and Projections

Frederick County conducted a GHG inventory of its government operations to understand current sources and drivers of its emission trends. The GHG inventory includes sources of emissions for 2010 and 2018 and projects GHG emissions through 2050 based on a business-as-usual scenario. The inventory is based on ICLEI's Local Government Operations protocol.

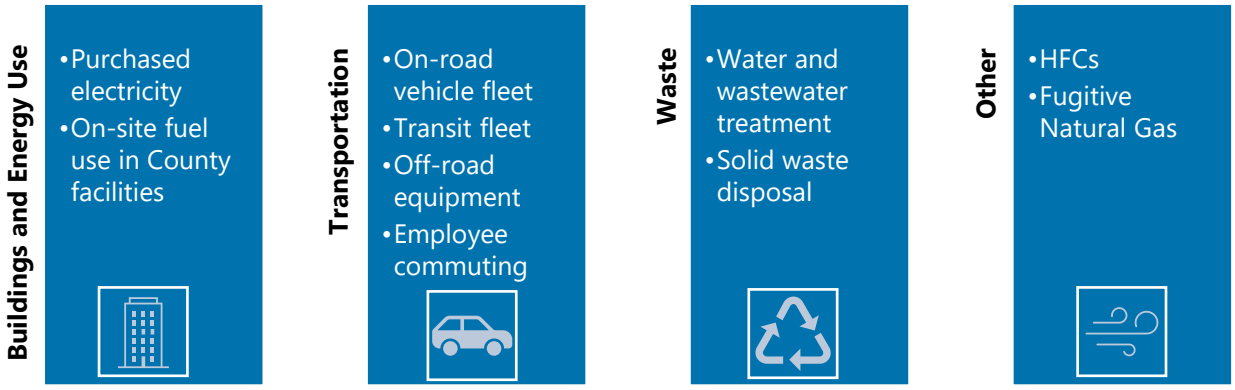
Key Findings of the GHG Inventory

The **largest sources of GHG emissions** from County operations include**:**

- Energy-related **Buildings and Facilities** emissions account for about half of the County government's emissions.
- **Buildings and Facilities** and **Transportation** sources together account for 80-90% of the County government's emissions

The inventory includes GHG emissions that result from sources over which the County owns or has operational control–the ability to introduce and implement changes in operational policies and processes.[1] Direct and indirect GHG emission sources are shown in Figure 1.

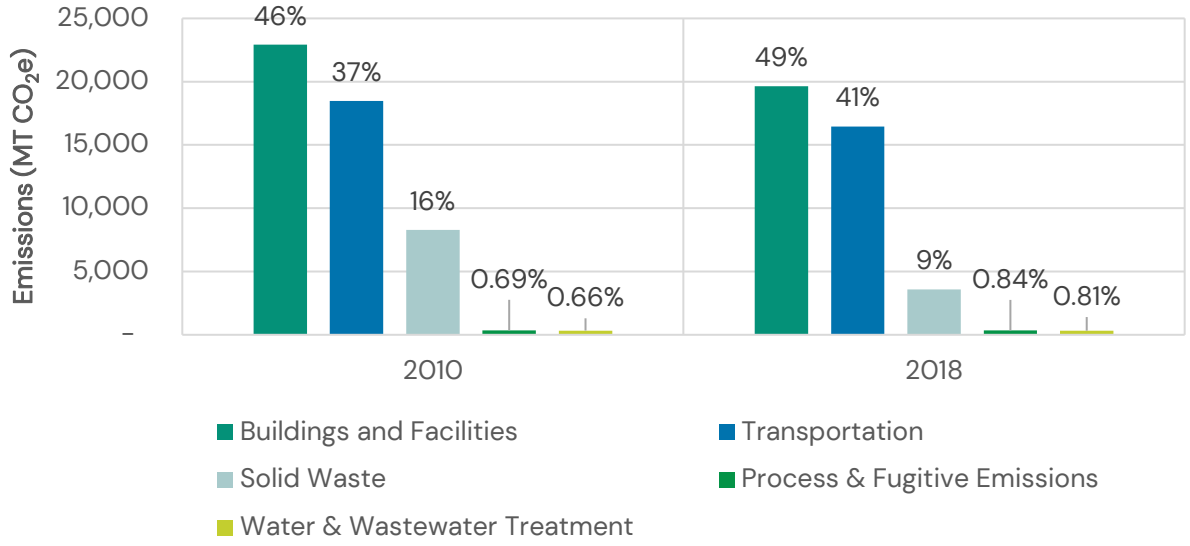
FIGURE 1: GHG INVENTORY SECTORS AND SOURCES



Results show the County emitted approximately 50,360 MT CO_2e in 2010 and 40,349 MT CO_2e in 2018 from government operations, a 20% reduction in emissions from 2010. Buildings and facilities were the largest source of GHG emissions in both 2010 and 2018, followed by transportation. Scope 1 (direct) emissions comprised 42% of total 2010 emissions and 40% of total 2018 emissions, driven by County fleet use.

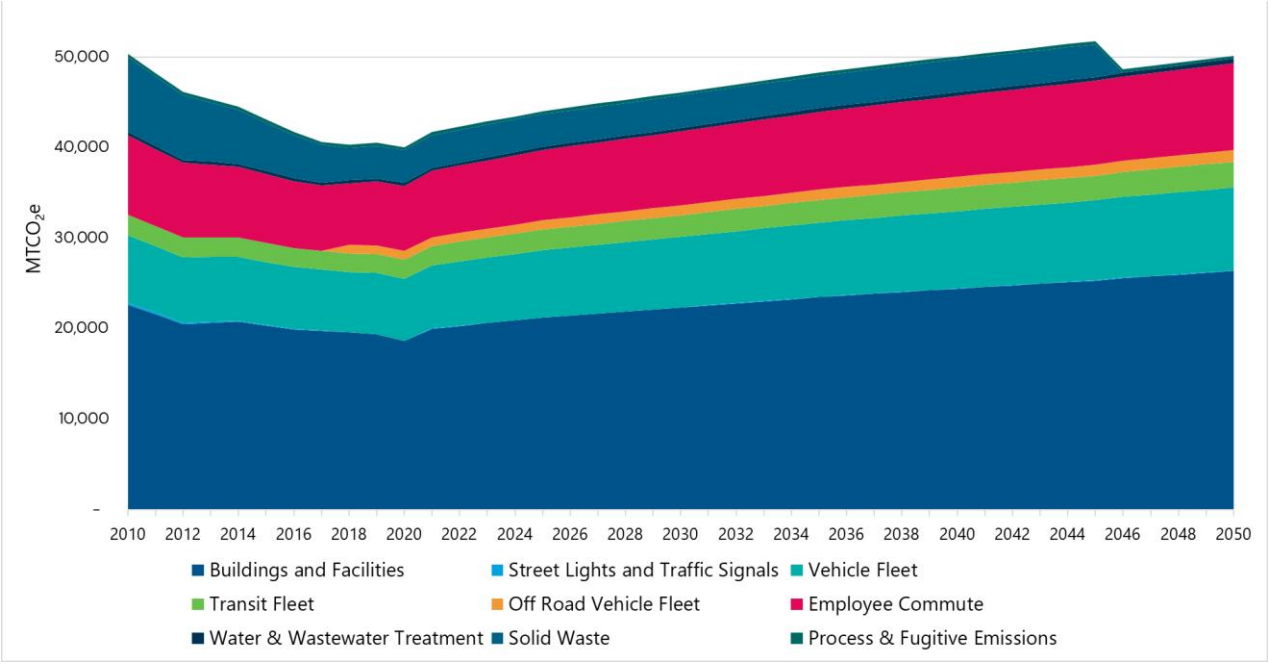
[1] The inventory excludes sources where emissions are likely to be less than 1% of total emissions or where data were not available.

FIGURE 2. 2010 AND 2018 GHG EMISSIONS BY SOURCE



Business-as-usual (BAU) projected emissions for 2019 to 2050 serve as a baseline to measure the impact of the County's emissions reduction strategies over the next decade. The BAU scenario shows projected trends under current conditions without factoring in the State of Maryland's Renewable Energy Portfolio Standard (RPS) or the implementation of additional activities to reduce GHG emissions. A reference case was also developed that assumes Maryland meets the state RPS. The County's overall GHG emissions from government operations are projected to decrease by just under .5% from 50,360 MT CO_2e in 2010 to 50,196 CO_2e in 2050. As seen in Figure 3, projections show emissions drop in 2020 before starting to increase again.

FIGURE 3. 2010 THROUGH 2050 REFERENCE CASE EMISSIONS BY SOURCE WITH BAU PROJECTIONS



Climate Mitigation Scenario Analysis and Strategies

The CEAP identified twelve strategies the County can take to reduce emissions across the largest sources of the County government emissions in the Buildings and Energy Use, Transportation, and Waste sectors. The CEAP modeled emission reductions for nine of the strategies in the Buildings and Energy Use and Transportation sectors. The implementation of these strategies will result in a projected 60% reduction in GHG emissions from 2010 levels by 2030.

Key Findings of the GHG Mitigation Analysis

This GHG mitigation analysis identified priority strategies to reduce GHG emissions from County government operations. **The strategies with the highest potential to reduce GHG emissions by 2030 include:**

- Procuring **100% renewable electricity**
- **Electrifying the County government's vehicle fleet**

TABLE 1: RECOMMENDED MITIGATION STRATEGIES WITH CO-BENEFITS

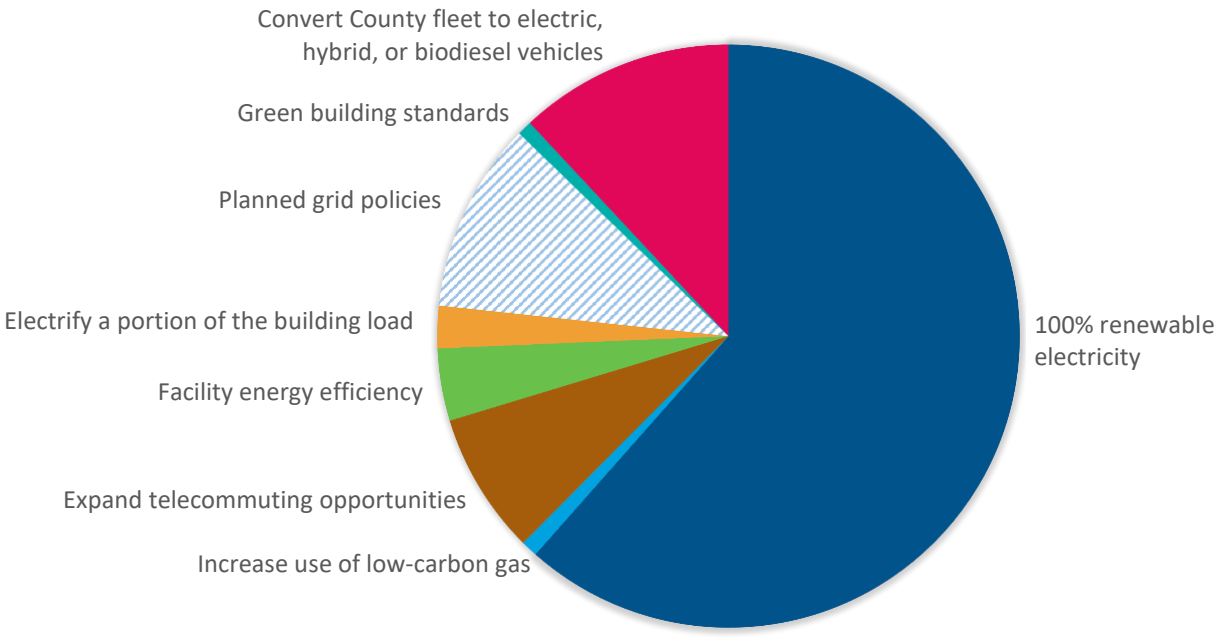
	Reduces:				**Supports Transition To:**	
Mitigation Strategy	Electricity Use	Natural Gas Use	Mobile Fuel Use	Waste Generation	Renewable Energy	Cleaner Mobile Fuels
Buildings and Energy Use						
E1 Renewable Energy Procurement					✓	
E2 Low-Carbon Gas		✓				
E3 Green Building Standards	✓	✓				
E4 Building Energy Efficiency	✓	✓				
E5 Building Electrification		✓				
Transportation						
T6 Electric Vehicle Adoption						✓
T7 Hybrid Replacement Program						✓
T8 Diesel to Biodiesel Conversion						✓
T9 Telecommuting			✓			
Waste						
W10 Increase County Waste Diversion				✓		
W11 Reduce County Employee Waste Generation				✓		
W12 Sustainable Purchasing and Procurement				✓		
E = Energy, T = Transportation, W = Waste						

After implementing these strategies, the County is projected to emit 20,165 MT CO2e in 2030 compared with BAU scenario emissions (i.e., if no additional mitigation actions were implemented) of 46,137 MT CO_2e in 2030 as shown in Table 2 below. Figure 4 shows various mitigation strategies and their contribution towards 2030 GHG reductions relative to each other.

TABLE 2: COMPARISON OF 2010 AND 2018 EMISSIONS WITH PROJECTION SCENARIOS IN 2030

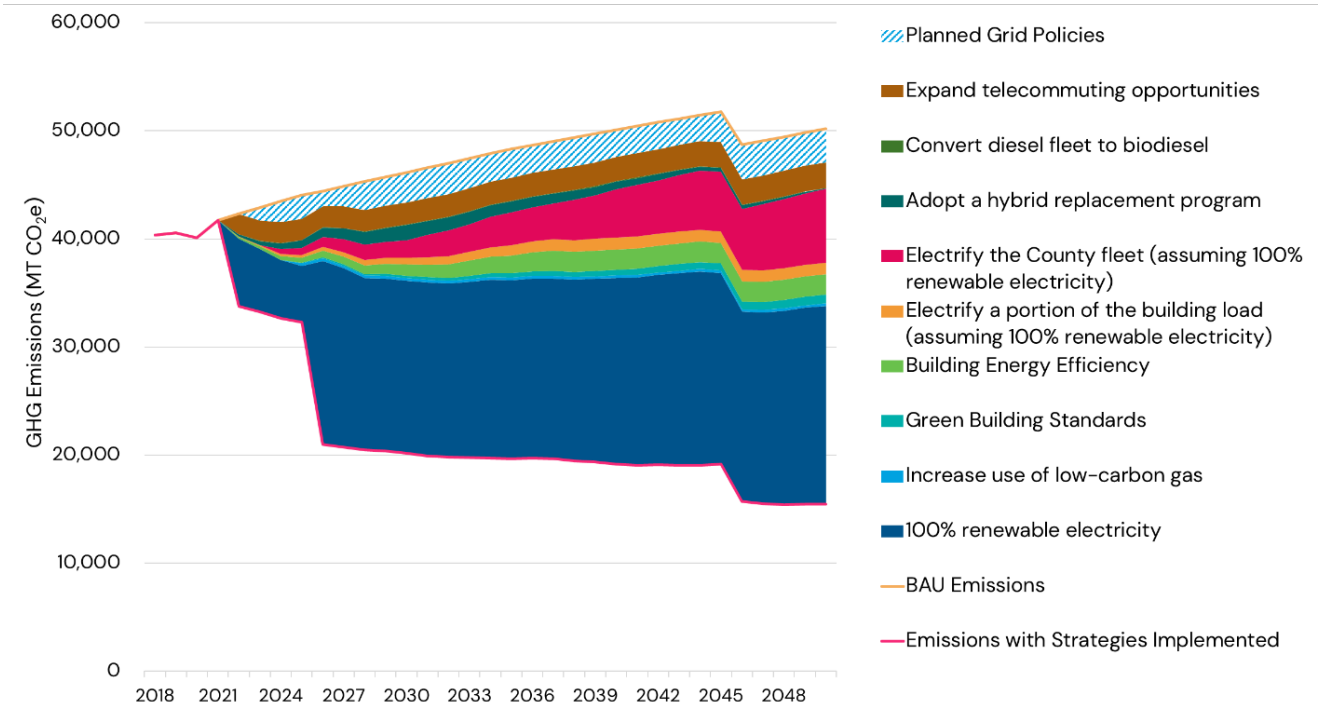
Emissions Source / Sector	Emissions (MT CO_2e)			
	2010 Baseline	2018 Progress	2030 BAU	2030 With Mitigation
Building and Energy (including Streetlights)	22,918	19,639	22,393	1,567
On-Road Vehicle, Transit, and Off-Road Fleet	9,671	9,621	11,256	8,152
Employee Commute	8,799	6,837	8,169	6,127
Water & Wastewater Treatment	334	325	380	380
Solid Waste	8,292	3,589	3,589	3,589
Process & Fugitive Emissions	346	338	349	349
Total GHG Emissions	**50,360**	**40,349**	**46,137**	**20,165**

FIGURE 4: MITIGATION STRATEGIES TO REDUCE CO_2 EMISSIONS BY 2030



As shown in Figure 5, by implementing the mitigation strategies outlined in this plan, the County will reduce its operational GHG emissions by 69% (34,740 MT CO_2e) from the BAU scenario resulting in 15,456 MT CO_2e, compared to 2050 BAU levels of 50,196 MT CO_2e. Compared to 2010 emissions, GHG emissions from the building and energy use sector will be about 95% lower in 2050 after implementing the GHG mitigation strategies in this plan.

FIGURE 5: GREENHOUSE GAS REDUCTIONS BY MITIGATION STRATEGY VERSUS BAU SCENARIO



Climate Risk and Vulnerability Assessment

The climate risk and vulnerability assessment (CRVA) identifies potential risks to County division assets and operations from the impacts of climate change. The findings of the CRVA then inform the development of forward-looking resilience actions that will help County decision makers prepare for future climate conditions. Additionally, the CRVA discloses material risks to investors as well as citizens that the County serves. The CRVA is aligned with the County's 2022 Hazard Mitigation and Climate Adaptation Plan (HMCAP), though the CRVA focuses specifically on natural hazards related to climate change.

Key Findings of the CRVA

This CRVA identified priority risks, which helped inform the resilience solutions discussed in the following chapter. **The study team found that high-priority risks across sectors include:**

- **Flooding leading** to **interruptions** in Division operations or use of assets; **damage** to infrastructure, and water or environmental **contamination** and resulting **human health impacts**.
- **Extreme heat** leading to **human health impacts** and **stress to County infrastructure.**

This CEAP is aligned with Frederick County's 2022 update to the HMCAP: both plans consider how climate change may impact the County and identify potential strategies for reducing risk. However, there are key differences: the HMCAP covers a wide range of natural hazards, while the CEAP focuses only on natural hazards related to climate change, including several that are not included in the HMCAP; and the HMCAP takes a broader view and identifies hazards to the entire County whereas the CEAP focuses on climate impacts to County assets and operations.

Methodology

The CRVA uses the best available science to estimate future climate conditions in Frederick County.[2] The study focuses on future conditions in 2050 to align with County government planning timelines, and longer-term horizons to create a picture of what the future may hold.

The climate projections informed the identification of ways climate hazards might impact County government operations and assets. The County identified key risks and determined which were considered "high consequence"–meaning risks that would result in severe injury or death, halt normal operations, require replacement of an asset, and/or add significant costs.

[2] Data for precipitation and heat climate variables come from the National Oceanic and Atmospheric Administration (NOAA). Data for winter storms and drought come from the National Integrated Drought Information System, the Maryland State Climate Summary, and scientific literature.

Results

Frederick County is projected to experience gradual increases in daily average temperature as well as more days with extreme heat each year. The number of extreme heat days—where temperatures hit 95°F or above— is expected to increase from a historically observed **2-3 days per year** to a future estimated **19-26 days per year by 2050 and 27-62 days by 2090**. Impacts of higher temperatures include greater energy needs and threats to human health.

The total amount of **precipitation falling each year is not projected to change greatly**, but **rain events will become less frequent and more intense.** Heavy rainfall events elevate the risk of flooding. **Flooding is a major risk** for the County, which has experienced nine major storms with disaster declarations for consequent flooding since 1953. **Winter storms are becoming more intense** with the 2022 HMCAP estimating the County experiences 10 to 11 severe winter events each year, up from 6 to 7 in the 2017 Hazard Mitigation Plan.

As precipitation falls less frequently, the **risk of droughts is projected to increase,** which could be especially damaging for the County's agriculture.

Social Vulnerability

The impacts of climate change are not evenly distributed. **Minority, disabled, elderly, youth, and low-income populations are more at risk** because they may have a difficult time recovering from property damage and interruptions in school or employment, affording repairs or relocation costs, or accessing necessary health or social services after extreme weather events. Minority and low-income communities are often more exposed to climate risks, such as living in areas with less tree cover, which has been linked to higher average temperatures. The County's community is less vulnerable to climate impacts than the average county in the United States based on socioeconomic, household composition, minority status, and housing type and transportation. Investments in climate resilience will have the greatest impact in areas in the County that are at higher risk to climate impacts due to socioeconomic characteristics and exposure to climate hazards.

Risk Prioritization

The County determined that **flooding and heat present the greatest level of risk to Frederick County Government operations**. These climate hazards currently present a high level of risk, expected to increase in the future due to climate change, particularly extreme heat.

Priority risks for flooding include interruptions to County services and use of County assets; damage to infrastructure; and human health impacts. Priority risks for heat include negative impacts to human health and stress to County infrastructure. In addition, both flooding and heat can result in power outages, highlighting the need for backup power across County divisions. Table 3 provides an example of the priority risks for some divisions and their assets.

TABLE 3: EXAMPLES OF PRIORITY RISKS TO COUNTY DIVISIONS

County Divisions	Priority Risks
Water and Sewer Utilities	**Flooding**: Sewer facilities flooding; water supply contamination; damage to water treatment plants **Heat**: electric grid outages; damage to wastewater treatment plant electric equipment; increased evaporation
Fire and Rescue Services Emergency Management	**Flooding**: Impassable roads; inhibiting emergency response; increased need for rescues **Heat**: Negative impacts on health of citizens and responders; increased heat-related health emergencies; stress on operating limits for vehicles
TransIT Services Public Works	**Flooding**: Damage to infrastructure and fleet; difficulty for users to access transportation (especially paratransit); impassable roads **Heat**: Transit vehicles and operators overheating; heat stress and health impacts to passengers waiting for transit services, cyclists, and pedestrians

In addition to the priority risks identified, several additional risks were identified that were not deemed high consequence. These include increased maintenance and repair costs to infrastructure and buildings due to flooding, increased safety risks due to more frequent days with extreme heat and flood events, and increased risks to public safety from delayed emergency response due to extreme events.

Resilience Strategies for Climate Risks

Climate resilience is the ability to prepare for, recover from, and adapt to climate risks.[3] A related concept, **climate change adaptation**, refers to those actions taken to prepare for and adjust to actual or expected climate changes, thereby mitigating harm, building resilience, and/or taking advantage of new opportunities.[4]

Strategies to help the County prepare for and adjust to climate changes were developed based on the priority climate risks to County government operations identified in the previous section. These consist of actions the County can take to mitigate climate change impacts and incorporate climate resilience into operations, policies, and infrastructure planning and maintenance. The recommended strategies and associated actions in this CEAP build on the

[3] Center for Climate and Energy Solutions. 2019. "What is Climate Resilience and Why Does it Matter?" Available at: https://www.c2es.org/wp-content/uploads/2019/04/what-is-climate-resilience.pdf.

[4] U.S. Global Change Research Program. 2014. "Chapter 28: Adaptation. Climate Change Impacts in the United States: The Third National Climate Assessment." Available at: https://nca2018.globalchange.gov/chapter/28/.

strategies from the HMCAP, the CEMWG Climate Response and Resilience Report, and the Metropolitan Washington Council of Governments' 2030 Climate and Energy Action Plan.

A broad list of resilience strategies was identified based on the County's previous resilience work, stakeholder input from County divisions, and the findings of the CRVA. The list was refined using the 2022 HMCAP to ensure continuity with existing climate resilience efforts. Discussions with County divisions further refined remaining strategies and identified gaps. The list of actions was finalized and organized into a set of broad, overarching strategies.

The study team identified **14 overarching resilience strategies** to address key risks and vulnerabilities, each with its own subset of specific adaptation actions. The strategies in this section build upon existing risk mitigation efforts and address gaps in policies and plans to identify areas where the County can act to further strengthen climate resilience.

Adapting to climate change and building resilience will be an ongoing process. Additional work will be needed to refine and implement these resilience strategies, including conducting more community outreach and further taking into account important considerations such as equity and evolving regional and State policies. Developing division-specific strategies will also require significant input from and across divisions to ensure a collaborative vision of a resilient future.

Addressing climate risks and building resilience help the County save operational and maintenance costs incurred by impacts from climate change and better serve constituents by maintaining access to critical services during disaster events. In addition, addressing climate risk can benefit the County's ability to finance capital improvements over time. Bond credit rating agencies now consider climate change as part of their evaluation of credit for local governments, taking into consideration the potential impacts of climate change on the financial health of the local governments and the local government's ability to repay. The presence of unaddressed climate risks could negatively impact the County's rating and increase the cost of borrowing/interest rates. On the flip side, **climate adaptation and resilience efforts can help ensure that a local government maintains strong credit ratings.**

In order to ensure that the County's climate resilience goals are achieved, it is important to monitor progress and periodically update next steps. Monitoring includes updates on progress towards implementing the actions laid out in this plan. It also means regularly updating the website to help readers understand what risks the County is facing and the importance of building resilience to climate change.

Table 4: Proposed Resilience Strategies

Hazard	Proposed Strategy
Multi-Hazard	▪ Ensure resilience efforts are equitable and support environmental justice ▪ Assess and update codes and ordinances to be climate risk informed ▪ Ensure emergency management and event response plans are climate risk informed ▪ Advance monitoring and awareness of green infrastructure and nature-based solutions that meet County climate and operational goals ▪ Build in resilience considerations into budgeting and capital improvement processes ▪ Develop and adopt indicators and inter-division collaboration mechanisms to monitor and adaptively manage climate resilience measures over time ▪ Install generators/backup power at critical facilities
Flooding	▪ Develop deeper understanding of flood vulnerabilities ▪ Build overall resilience to stormwater flooding ▪ Prevent flood-related interruptions to County services and/or use of County assets ▪ Increase resilience of County infrastructure to flood-related damage ▪ Understand and reduce risk of water contamination
Heat	▪ Protect human health from extreme heat ▪ Increase resilience of County infrastructure to extreme heat

Next Steps

This CEAP describes actions that Frederick County can take to incorporate climate change considerations into government operations, reduce its footprint, save money, create healthier and safer working conditions for County employees, protect economic activity, and increase resilience to the impacts of climate change.

Throughout implementation of the mitigation and resilience strategies described in this plan, the County will need to take steps to institutionalize climate action in its operations—for example, conducting regular monitoring of progress and establishing reporting processes and accountability.

Implementation of this plan will require support across agencies and staff as well as adequate funding. Ultimately, enactment– of the CEAP will help Frederick County meet its climate change goals and demonstrate its commitment to address climate change.

1 Introduction

1.1 The Case for Climate Action

Climate change is occurring at both global and local scales and presents communities and governments with an unprecedented challenge. Based on current projections, extreme weather and other climate hazards are likely to become more intense and frequent throughout the region. Frederick County will need to reduce emissions and advance climate change resilience efforts to have the proper infrastructure and resources necessary to face these challenges.

Frederick County is already experiencing climate change impacts, posing threats to the County's jobs, health, and quality of life. The most prominent climate hazards that Frederick County faces include extreme heat, flooding, winter storms, and drought. Between 1994 to 2013, the County experienced about 17 days per year with maximum temperatures above 90°F.[1] In 2021 and 2022, the County experienced 46 and 44 days above 90°F, respectively.[2] Since 1953, there have been 13 major disaster declarations for Frederick County, of which nine were for severe storms and consequent flooding.[3]

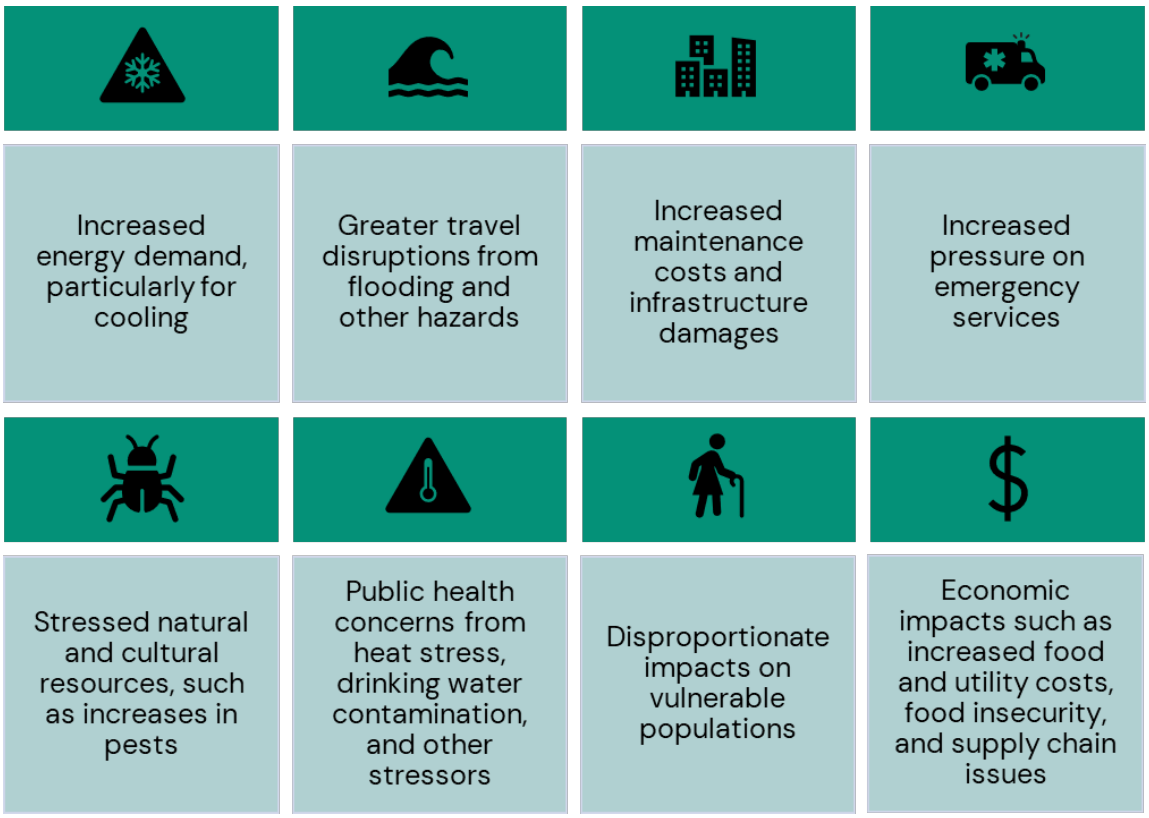
More frequent and intense climate hazards in Frederick County are predicted with climate change. See Figure 1 for details.

[1] U.S. Federal Government. 2021. U.S. Climate Resilience Toolkit Climate Explorer. https://crt-climate-explorer.nemac.org/.

[2] AccuWeather. 2022. "Frederick Maryland." Available at https://www.accuweather.com/en/us/frederick/21701/october-weather/329303?year=2021.

[3] Frederick County. 2022. Frederick County Hazard Mitigation and Climate Adaptation Plan.

Figure 1: Expected hazard changes to Frederick County due to climate change.



These trends will worsen without action on local, state, federal, and global levels to mitigate greenhouse (GHG) emissions. The concentration of carbon dioxide (CO_2) in the atmosphere has reached the highest level in the last 800,000 years.[4] Emissions of greenhouse gases (GHGs), driven largely by human activities such as the burning of fossil fuels for energy and transportation, have increased substantially since the preindustrial era. As the level of CO_2 and other GHGs in the atmosphere continues to increase, there will be increasingly significant changes to climate that will be felt in Frederick County. To address these impacts, the County needs a substantial, sustained effort to meet its climate goals to mitigate GHG emissions and adapt the County's behavior and systems to protect people, the economy, infrastructure, and the environment to a changing climate.

The development of this Climate and Energy Action Plan (CEAP) for Frederick County Government operations marks one of multiple efforts the County is taking to confront both climate change mitigation and adaptation. This CEAP details opportunities to both reduce GHG emissions and improve resiliency and provides information to coordinate next steps on implementation.

[4] Climate.gov. 2020. "Climate Change: Atmospheric Carbon Dioxide." Available at https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

Benefits of the Climate and Energy Action Plan

Done well, our efforts will:

- Save tax dollars;
- Protect public health and infrastructure;
- Reduce harmful impacts of climate change on the County;
- Increase the resilience of government assets and operations;
- Provide economic opportunity;
- Increase benefits from improved technology;
- Increase our energy independence;
- Address material issues related to climate impacts in financial reporting; and
- Attract state and federal funding to help achieve our goals.

1.2 Responsibilities and Momentum on Climate Action

Frederick County Government has a responsibility to exhibit climate leadership at this pivotal moment in defining the County's future. The United States recently pledged to reduce its emissions 50-52% by 2030 compared to 2005 levels.[5] Pressures from the State and the Metropolitan Washington Council of Governments (MWCOG) – of which Frederick County is a member jurisdiction–are mounting for local jurisdictions to become more sustainable and drastically reduce emissions at least 50% by the end of this decade.

Frederick County has been taking action on climate change since the early 2000s, as summarized in the timeline in Figure 2.[6] Frederick County will need to build on its accomplishments to date and accelerate its contributions towards collective action on reducing greenhouse gas emissions and enhancing resilience to climate risks.

[5] U.S. White House. 2021. FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies. Available at https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.

[6] In the 2019 box, a LEED Silver community is a certification given by the U.S. Green Building Council to places that have demonstrated progress towards and commitment to sustainability, net-zero, resilience, and social equity. For more information, see https://www.usgbc.org/leed/rating-systems/leed-for-cities-communities.

In the 2020 box, note that the Climate Emergency Mobilization Workgroup was established by County Council and was a made up of community volunteers.

Figure 2: Frederick Government Climate Actions

2007	Frederick County develops its first **greenhouse gas inventory** for community and County government operations.
2010	Frederick County develops its first **Comprehensive Energy Plan.**
2011	Frederick County installs a **solar water heater** at the Adult Detention Center.
2012	Frederick County updates the **greenhouse gas inventory for County operations.**
2013	Frederick County receives its first **Power Saver Retrofits grant,** adopts its first resolution as a **Maryland Smart Energy Community**, and completes projects including adding electric buses to the fleet and LED lighting retrofits.
2016	Frederick County develops its **Livable Frederick Master Plan** to provide a roadmap for sustainability that addresses climate change and establishing frameworks to meet strategic goals. Frederick County completed purchase of first electric buses.
2019	Frederick County completes a **1.9 MW solar array** on a closed landfill to supply energy to County buildings and electric buses and a **1 MW solar array** at the Ballenger-McKinney Wastewater Treatment Plant. Frederick County is certified as a **LEED Silver** community. Frederick County begins to update its **Comprehensive Energy Plan** for FY 2020-23.
2020	The **Frederick County Climate Emergency Resolution is approved, committing the** Council to implement policy and legislative actions through the lens of climate change. The **Climate Emergency Mobilization Workgroup (CEMWG**) is established to provide recommendations on implementing climate strategies.
2021	County Executive Jan Gardner and County Council launch comprehensive **climate initiatives.**
2022	The County Council approves the climate initiatives. Frederick County updates the **Hazard Mitigation and Climate Action Plan (HMCAP)** and starts developing an **Alternative Fuel Vehicle (AFV) Transition Plan** and a **Climate and Energy Action Plan**.

To supplement ongoing climate mitigation efforts, the County is also embarking on climate adaptation efforts, given the need to proactively prepare for impacts. The County recognizes the imperative to focus on climate adaptation and resiliency to further advance the County's 2022 Hazard Mitigation and Climate Adaptation Plan update, contribute towards regional coordination to address climate risks that are not confined to County lines, and prepare for impending regulatory requirements.

This 2022 CEAP is different from the County's climate actions to date, in that it aligns actions into a regional planning effort that adds up to global action. Through this CEAP, Frederick County defines a pathway to meet local climate goals and advances action that will help meet statewide climate goals, such as Maryland's Greenhouse Gas Reduction Act to reduce 50% of emissions by 2030 and requirements in the Climate Solutions Now Act of 2022. In addition, MWCOG developed a regional 2030 Climate and Energy Action Plan (CEAP) that includes a GHG reduction strategy and Climate Risk and Vulnerability Assessment. Frederick County's CEAP supports the goals of the MWCOG CEAP – which follows the framework of the Global Covenant of Mayors and was developed with their guidance – and directly echoes the structure of the regional plan.

Alignment with recent County Climate and Energy initiatives

In December 2021, County Executive Jan Gardner announced a new series of Climate and Energy initiatives that Frederick County will pursue to combat climate change. These initiatives included developing climate and energy action plans, electrifying the County's fleet vehicles and creating alternative fuel vehicle infrastructure programs, improving building energy use and the resilience of County buildings, and increasing clean energy procurement in the County. The County Council approved these initiatives in January 2022. This internal operational CEAP represents one of the County Executive's initiatives and provides a vision to address climate change in the County's government operations.

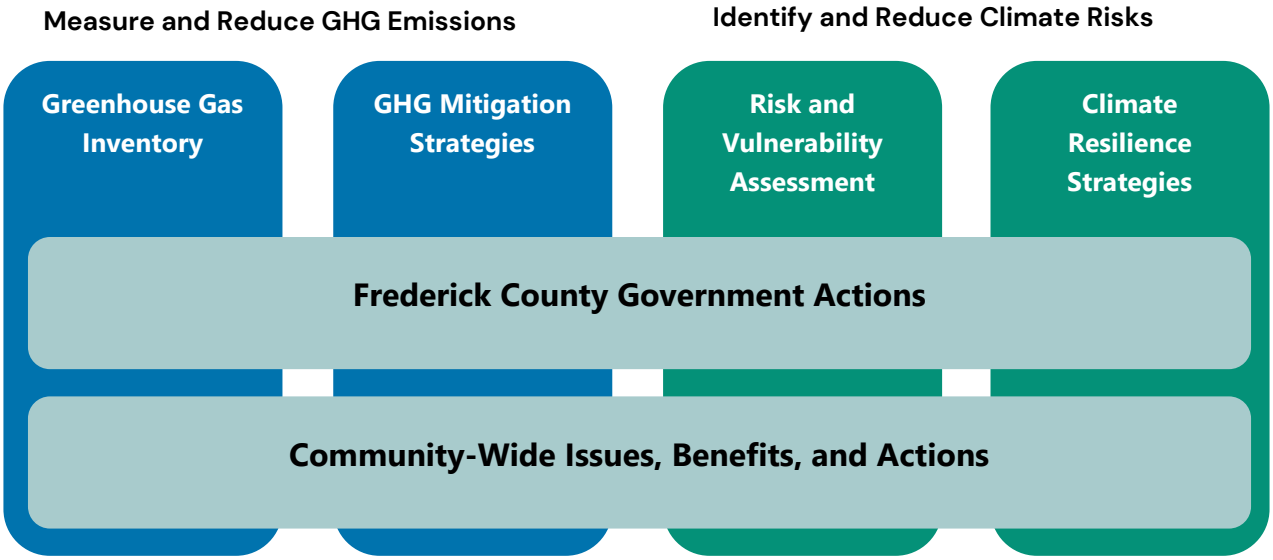
In addition to directives from the County Executive, the County and other local entities have completed or are actively engaging in efforts to develop plans, policies, partnerships, and recommendations aimed at addressing and preparing for climate change. Through a resolution in July 2020, the Frederick County Council established the Climate Emergency Mobilization Workgroup that commits to "implementing policy and legislative actions through the lens of climate change" and to create "equitable climate emergency mobilization efforts to address global warming, reduce county-wide greenhouse gas emissions 50% from 2010 levels by 2030 and 100% no later than 2050, and employ efforts to safely drawdown carbon from the atmosphere." This Workgroup met for a year and presented its Report in August 2021; the Report details recommendations for how the County could address climate change.

These local and regional efforts overlap with the goals of this CEAP and have been considered throughout its development. By aligning multiple efforts taken by the County through this CEAP, the County develops a comprehensive pathway to guide progress towards climate goals for County staff across a range of divisions and day-to-day responsibilities.

1.3 Objectives and Scope of the Frederick County Climate and Energy Action Plan

This CEAP provides a roadmap for the County to reduce its contribution to climate change and prepare for the new conditions that will accompany a changing climate. The CEAP documents Frederick County Government's strategy to measure and reduce greenhouse gas (GHG) emissions from County operations that contribute to climate change, and to identify and reduce climate risks. This CEAP focuses on Frederick County Government actions. Future planning efforts will address what the community can do. The alignment of these CEAP efforts is represented in Figure 3.

Figure 3: Elements of Climate and Energy Action Plan for Frederick County



The primary objectives of this CEAP are to:

- Describe the County's GHG emissions sources and business-as-usual projections through 2050, including a discussion of base year (2010) and progress year (2018) GHG emissions.
- Identify and estimate the impact of GHG reduction actions to achieve its climate targets.
- Assess the risks and vulnerabilities posed to County government operations and County-managed assets under a changing climate, including from extreme heat, flooding, drought, and extreme winter conditions.
- Identify and recommend operational strategies to improve the resilience of the County government to climate change.
- Consider and incorporate the impact of parallel actions the County is taking, such as developing an Alternative Fuels Vehicle Plan.
- Provide key next steps and related guidance to facilitate implementation of GHG reduction and resilience actions outlined in this Plan and track progress towards goals over time.

This CEAP focuses on County internal government operations and does not include GHG emissions from or climate risks to the broader community, private sector, or households. Sources of emissions that are considered in-scope for this CEAP include:

- Energy use (i.e., stationary fuel use and electricity use) at County buildings and other facilities, including waste management and water or wastewater treatment facilities, that the County owns or operates,
- Electricity use from streetlights and traffic signals that the County owns or operates,
- Fleet vehicles that the County owns or operates,
- Non-fleet vehicles and equipment (e.g., lawn mowers, utility equipment) that the County owns or operates,
- Solid waste treated at the County-operated landfill,
- Employee commuting, and
- Fugitive emissions from natural gas distribution and refrigerant leakage.

While Frederick County Government only represents a portion of the County's overall carbon footprint, the County government's commitment to meeting climate targets through strategies such as those described in this CEAP reduces material risks, demonstrates accountability and offers leadership by example for the broader community to use as a model and resource. The County can leverage this comprehensive government-focused plan as a starting point to collaborate with the broader community and reduce the County's overall footprint and enhance the County's overall resilience.

To ensure that the CEAP stays up-to-date and continues to be a resource for moving the County's goals for sustainability and resilience forward, FCG will update this Plan at regular intervals (e.g., every 5 years). For each update, FCG will integrate the most up-to-date emissions data and climate science, adjusting strategies as needed to account for progress and any changes in both opportunities and risks.

2 Greenhouse Gas Inventory and Projections

A local government operations (LGO) greenhouse gas (GHG) emissions inventory serves as a foundational tool to identify primary sources of GHG emissions, inform decision-making about potential reduction opportunities, and help track the County's footprint over time. This section describes the LGO inventory and GHG emissions projections that were developed for Frederick County by the Metropolitan Washington Council of Governments (COG). A baseline GHG inventory of County government operations for 2010 was developed, as well as an interim year inventory for 2018. Additionally, COG developed business-as-usual (BAU) projections and Reference Case projections to the year 2050. The LGO inventory and projections allow the County to understand the emissions impact of its operations, identify key sources and drivers of emissions, set targets, and ultimately track progress toward reduction goals. This section provides a brief overview of GHG inventories, reviews the results of the County's GHG inventories for 2010 and 2018, and identifies and discusses the sectors responsible for GHG emissions from County operations – principally building energy use and transportation. This section then discusses the results of the BAU projections and Reference Case projections.

This chapter presents the following information:

Key Findings

This GHG inventory identified the primary sources of direct and electricity-related GHG emissions from County government operations, which helped inform the GHG reduction strategies discussed in the following chapter. **The County's largest sources of GHG emissions from County operations include:**

- Energy-related **Buildings and Facilities** emissions account for about half of the County government's emissions
- **Buildings and Facilities** and **Transportation** sources together account for 80-90% of the County government's emissions

- **Overview**: Describes key components of a GHG inventory, including common sources of GHG emissions and how emissions are categorized.
- **Scope of the Inventory**: Describes the specific sources of emissions included in FCG's GHG inventory.
- **Emissions Inventories**: Discusses the results of the baseline 2010 and progress year 2018 GHG emissions inventories.
- **Projections: 2019 to 2050**: Describes projected emissions from FCG operations under business-as-usual and reference case scenarios.

2.1 Overview

A GHG inventory quantifies the GHG emissions that results from an organization's activities. Specifically, a GHG inventory estimates emissions of GHGs—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and Hydrofluorocarbons (HFCs)—from common sources of emissions such as building electricity use, transportation, and waste disposal.

This inventory follows ICLEI's Local Government Operations (LGO) Protocol and best practices for GHG accounting and reporting. ICLEI's ClearPath Tool was used to develop inventory estimates for all emissions sources. The inventory estimates emissions in metric tons of carbon dioxide equivalent (MT CO_2e).

Emissions can be categorized into "scopes," which classify direct and indirect sources of emissions, improve transparency, and avoid double counting of emissions across organizations. [7] Emission scopes are defined as:

- **Scope 1**: Direct emissions from sources that are owned or controlled by the County government (e.g., fuel use in government fleet vehicles).
- **Scope 2**: Indirect emissions associated with the use of purchased electricity, steam, heating, or cooling that occur at sources owned or controlled by another entity (e.g., utility) but as a result of the County government's activities.
- **Scope 3**: All other indirect emissions not covered in Scope 2, which occur at sources not owned by the County but result from the County government's activities (e.g., employee commuting to County facilities).

Global warming potentials and carbon dioxide equivalent explained

Global warming potentials (GWPs) allow for comparison of the impacts of different gases on climate change by measuring the impact to climate change of one ton of a gas relative to the emissions of one ton of CO_2. For example, the GWP for methane (CH_4) is 25, indicating that one metric ton (MT) of CH_4 is as effective as 25 MT of CO_2 at trapping heat in the atmosphere.

GWPs can change depending on time horizon analyzed. This inventory uses 100-year GWP values from the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4) to report emissions in metric tons of carbon dioxide equivalent ($MTCO_2e$). Using the AR4 GWP values is consistent with regional COG GHG inventories as well as the national U.S. GHG inventory.

The following section describes what is included in the County's GHG inventory.

2.2 Scope of the Inventory

The first step in developing a GHG inventory is defining the inventory boundaries. Inventory boundaries establish which activities, sources of emissions, operations, and time period are considered as part of a GHG inventory.

This LGO inventory includes GHG emissions resulting from sources over which the County owns and/or has *operational control*—defined as any facility or operation for which the County has the full authority to introduce and implement changes in operational policies and processes.[8] This includes:

- Buildings and other facilities that the County owns and operates,
- Streetlights and traffic signals,
- Fleet vehicles,
- Off-road vehicles and equipment (e.g., industrial equipment and construction equipment),
- Employee commuting,
- Water and wastewater treatment plants,
- Solid waste disposal at the County landfill, and
- Other process and fugitive emissions (including fugitive emissions from refrigerants and fugitive natural gas emissions).

[7] ICLEI. 2010. *Local Government Operations Protocol. Version 1.1.* See https://icleiusa.org/ghg-protocols/.

[8] ICLEI. 2010. *Local Government Operations Protocol. Version 1.1.* See https://icleiusa.org/ghg-protocols/.

The inventory excludes certain minor sources of emissions, or emission reductions for which data were not available, emissions were likely to be low (e.g., less than 1% of total emissions), or over which the County has minimal control. This includes:

- Carbon sequestration from urban trees
- Contracted services
- Emissions from County government waste landfilled outside of the County

While these categories are outside the scope of the current inventory, the County will still work on strategies such as procurement policies. However, the emission reductions associated with these strategies would not be directly attributed to the County's emissions as reported in this CEAP. The base year of the County's inventory is calendar year 2010 with an interim inventory for calendar year 2018. Baseline and interim years provide a historic point of comparison against which emissions performance is tracked over time.

The following sections describe how the COG developed the County's LGO inventory, results of the inventory, and BAU and Reference Case projected emissions through 2050.

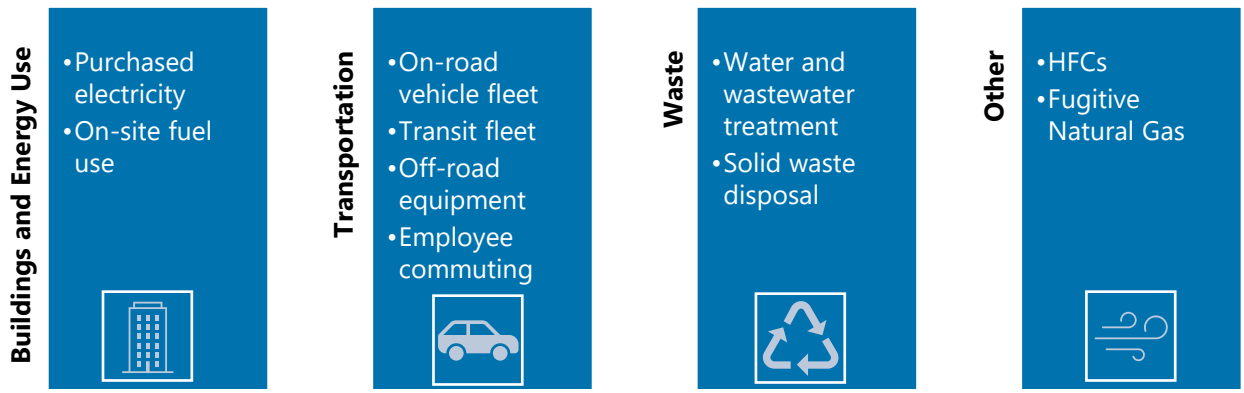
2.3 Emissions Inventories from 2010 and 2018

This inventory includes estimates for the following sources of emissions in County operations:

- Scope 1:
  - On-site fossil fuel combustion at County facilities
  - Mobile combustion in County fleet vehicles, transit fleet vehicles, and non-fleet vehicles and equipment
  - Wastewater treatment
  - Solid Waste disposal at the County landfill
  - HFCs from refrigerant leakage
- Scope 2:
  - Purchased electricity used by County facilities, streetlights, and traffic signals
- Scope 3:
  - County employee commuting

Emissions in this inventory are also assigned to the four sectors presented in Figure 4.

Figure 4: GHG Inventory Sectors and Sources



Emissions for each source were estimated using methods from ICLEI's LGO Protocol, unless otherwise specified (for example, where more localized or site-specific emission factors were available). Where data were unavailable, best practices were used to develop proxy data to support estimates.

Additional information on methodologies and assumptions for each emission source are available in Technical Appendix A: Inventory Methods.

2.3.1 Results

In 2010, Frederick County emitted approximately 50,360 MT CO_2e. In 2018, the County emitted approximately 40,439 MT CO_2e; a 20% drop in emissions from 2010. This drop coincides with a 9% decrease in County employees between the two inventory years. Frederick County's 2018 LGO inventory makes up 1.1% of community-wide emissions when compared to COG's 2018 Community-Wide GHG Emissions Inventory for the County. Figure 5 and 6 and Table 1 show LGO emissions by source.

Buildings and facilities energy consumption was the largest source of GHG emissions in both 2010 and 2018. The second largest source of emissions was transportation (including the County's vehicle fleet and employee commute emissions), followed by solid waste disposal as the third largest source.

Figure 5: 2010 and 2018 GHG Emissions by Source

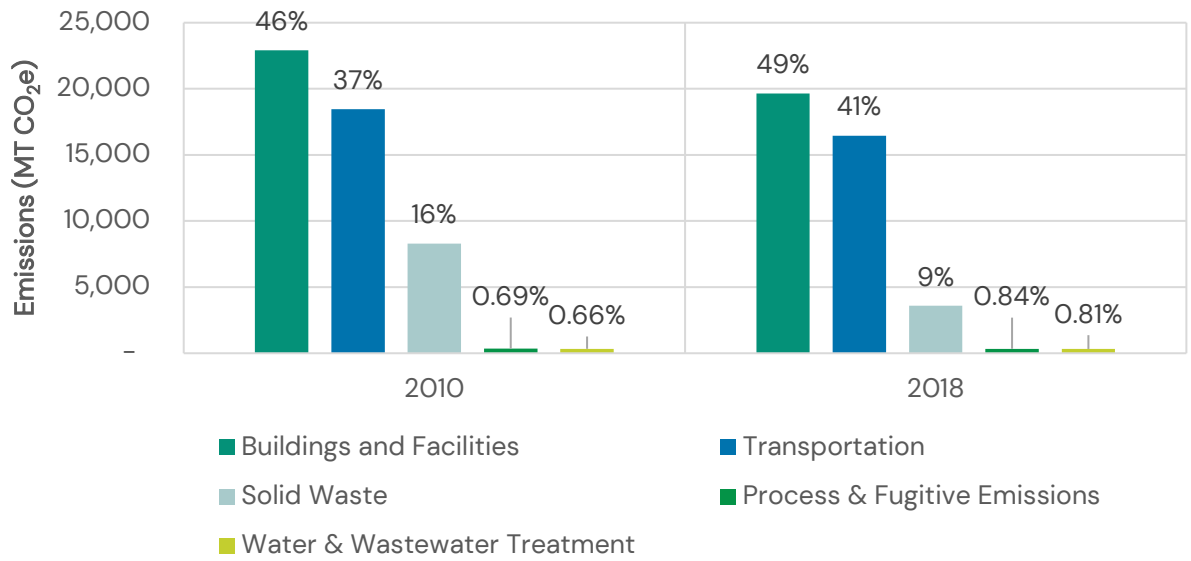


Figure 6: 2018 Percent GHG Emissions by Source

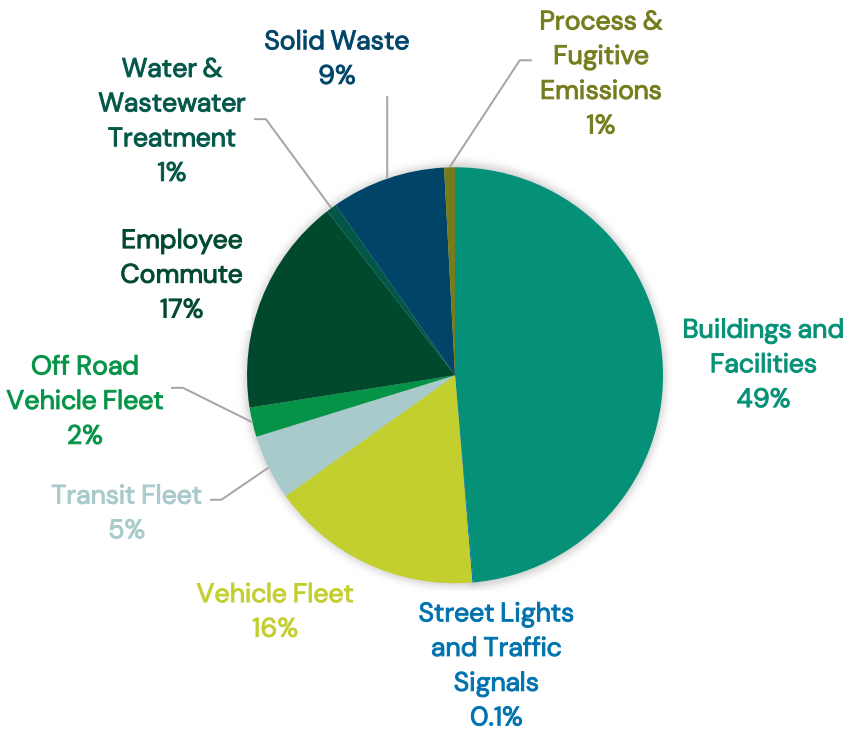


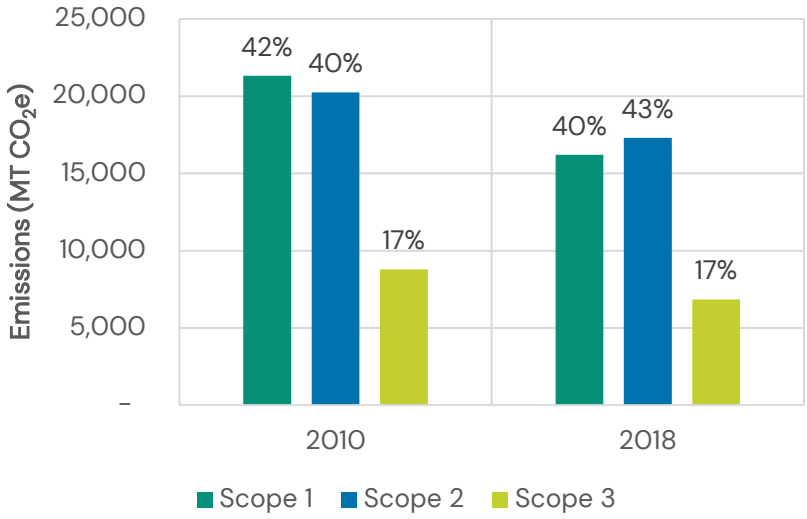
Table 1: 2010 & 2018 GHG Emissions by Source[9]

Emissions Source / Sector	Emissions ($MT CO_2e$)		% of Total		% Change 2010-2018
	2010	2018	2010	2018	
Buildings and Facilities	**22,918**	**19,639**	**46%**	**49%**	**-14%**
Purchased Electricity	19,992	17,265	40%	43%	-14%
Stationary Fuels	2,673	2,338	5%	6%	-13%
Streetlights and Traffic Signals	253	36	1%	0%	-86%
Transportation	**18,469**	**16,458**	**37%**	**41%**	**-11%**
Vehicle Fleet	7,419	6,646	15%	16%	-10%
Transit Fleet	2,252	2,049	4%	5%	-9%
Off Road Vehicle Fleet	-	926	0%	2%	-
Employee Commute	8,799	6,837	17%	17%	-22%
Water & Wastewater Treatment	**334**	**325**	**1%**	**1%**	**-3%**
Solid Waste	**8,292**	**3,589**	**16%**	**9%**	**-57%**
Process & Fugitive Emissions	**346**	**338**	**1%**	**1%**	**-2%**
HFCs	273	273	1%	1%	0%
Fugitive Natural Gas	73	65	0.1%	0.2%	-11%
Total GHG Emissions	**50,360**	**40,349**	**100%**	**100%**	**-20%**

[9] Off Road Vehicle emissions for 2010 are incorporated into Vehicle Fleet emissions, as this data was not broken down to same categories as 2018.

As shown in Figure 7, scope 1 (direct) emissions comprised 42% of total 2010 emissions and 40% of total 2018 emissions, driven primarily by County fleet use. Scope 2 (indirect) emissions comprised 40% of total emissions in 2010 and 43% of total emissions in 2018, driven by purchased electricity. Finally, Scope 3 (indirect) emissions comprised the remaining 17% of total 2010 emissions, as well as 17% of total 2018 emissions, largely driven by employee commute emissions.

Figure 7: 2010 and 2018 GHG Emissions by Scope



Between 2010 and 2018, Scope 1 emissions decreased substantially for 2 main reasons: first, waste tonnage sent to the County landfill decreased by more than half; second, emissions from the County's fleet and Transit fleet decreased due to fuel switching (diesel fuel consumption dropped by 12%, while gasoline consumption increased by 19% between the two inventory years).Scope 2 emissions from purchased electricity decreased between inventory years, while electricity consumption increased, including a large increase for the Water & Sewer Utilities. While overall Scope 2 emissions decreased due to the lower carbon intensity of the grid in 2018, they did so at a more gradual rate compared to the rapid decrease in Scope 1 emissions, due to the increase in electricity use. These factors result in the change in Scope percentage breakouts between inventory years.

The following sections describe sector-specific results of the inventory.

2.3.2 Buildings and Energy Use

Buildings and facilities energy consumption was the largest source of GHG emissions in 2010 and 2018. The combustion of fossil fuels for energy and heat generation results in emissions of CO_2, CH_4, and N_2O. Buildings and energy sector emission sources include on-site stationary fuel combustion (e.g., natural gas, diesel, propane, and digester gas) and purchased electricity in County-owned facilities. Purchased electricity was separated into four categories:

- Buildings and facilities, which includes all County-owned office buildings facilities,
- Water and sewer utilities, which includes the County's water and wastewater treatment plants, and associated pump stations,
- Solid waste and recycling, which includes the County's landfill facilities, and transfer station, and
- Streetlights and traffic signals, which includes all streetlights owned by the County.

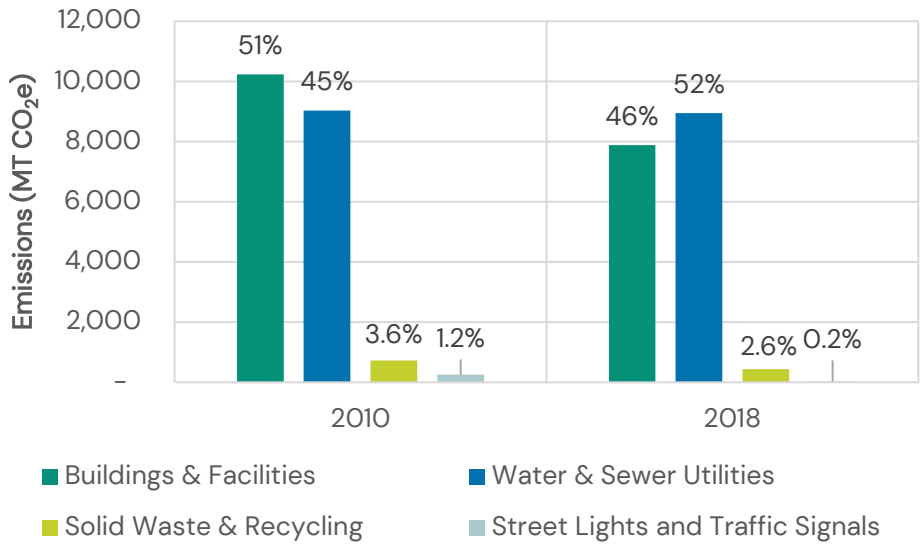
Overall, energy-related activities emitted 22,918 MT CO_2e in 2010 and 19,639 MT CO_2e in 2018, 46% and 49% of total emissions from County operations respectively. Emissions from the energy sector are impacted by 1) the amount and type of fuel combusted on-site, 2) on-site equipment technology and efficiency, 3) the amount of

electricity used in buildings and other facilities, and 4) the carbon intensity of the fuel mix of grid electricity generation (e.g., coal, natural gas, wind, or solar).

The largest source of emissions in the energy sector is purchased electricity, responsible for 19,992 MT CO_2e in 2010 and 17,265 MT CO_2e in 2018. In 2010, the County's buildings and facilities were the largest source of electricity emissions, followed by water and sewer utilities, solid waste and recycling, and, finally, streetlights and traffic signals. In 2018, water and sewer utilities were the largest source of electricity emissions, followed by buildings and facilities, solid waste and recycling, and streetlights and traffic signals. Figure 8 shows this breakout. Energy consumption at Frederick County's water and wastewater treatment facilities grew considerably between the two inventory years due to expanding operations and population growth. Overall, there was a 14% decrease in emissions associated with purchased electricity, which is largely due to the considerable cleaning of the electricity grid between the two inventory years. Figure 8 shows the breakout of electricity emissions by category.

Stationary fuel use (i.e., natural gas, diesel fuel, propane, stationary gas in buildings) emitted 2,673 MT CO_2e in 2010 and 2,338 MT CO_2e in 2018. Emissions from stationary fuel use were primarily from natural gas use in facilities.

Figure 8: 2010 and 2018 Electricity Emissions by Category



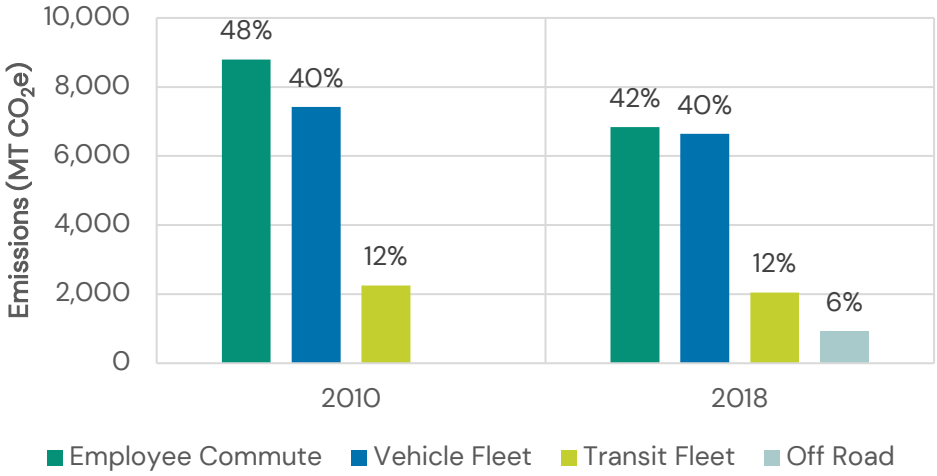
2.3.3 Transportation

The transportation sector was the second largest source of GHG emissions in 2010 and 2018. Transportation sector emission sources include fuel use in the County's fleet of on-road vehicles, transit fleet, and off-road equipment, as well as emissions from employee commuting. Emissions from the transportation sector are impacted by 1) the size, type, and efficiency of vehicles in the on-road fleet and off-road equipment inventory, 2) miles traveled by employees in County vehicles and in commuting to work, and 3) the type of fuel consumed by vehicles and equipment (e.g., gasoline, diesel, diesel, or electric vehicles).

Overall, transportation-related activities emitted 18,469 MT CO_2e in 2010, 37% of total County emissions. In 2018, this dropped to 16,458 MT CO_2e, and made up 41% of County emissions. Across both inventory years, the majority of transportation emissions can be attributed to employee commuting (48% and 42% in 2010 and 2018, respectively) and the County's vehicle fleet (40% and 46% in 2010 and 2018, respectively). The County's transit fleet made up 12% of transportation emissions across both inventory years. Off-road equipment emissions are included in the vehicle fleet for 2010 and broken out into a separate category in 2018, as this data

has become available. For 2018, 6% of County emissions were attributable to off-road equipment, such as specialized constructions machinery. Figure 9 shows the emissions from the transportation sector.

Figure 9: 2010 and 2018 Emissions from the Transportation Sector[10]



2.3.4 Solid Waste

The solid waste sector was the third largest source of emissions from County operations in both 2010 and 2018. This sector includes emissions from disposal of solid waste at the County's landfill (Reichs Ford Road Sanitary Landfill – Site B). Emissions from waste disposal are impacted by the amount of solid waste landfilled, the landfill gas (LFG) collection system, amount of LFG collected, fraction of methane in the LFG, and the methane collection efficiency.

In 2010, emissions from solid waste delivered to the landfill was 8,292 MT CO_2e, making up 16% of total emissions. In 2018, this decreased to 3,589 MT CO_2e (9% of total emissions). This halving of emissions occurred due to a 57% drop in solid waste tonnage delivered to the facility between the two inventory years.

Since 2005, the County's landfill has transferred most of its waste to an out-of-County waste disposal facility to preserve landfill capacity. The County's landfill continues to operate at a reduced tonnage acceptance rate. It accepts waste two weeks per year. The transferred waste is beyond the scope of the 2010 and 2018 LGO inventories, as disposal of community waste (i.e., residents and businesses) is not directly under the County's operational control.

2.3.5 Other Sources

Emissions from other sources include water and wastewater treatment emissions, and process and fugitive emissions from HFCs (associated with refrigerant use) and fugitive natural gas leaks. Emissions from water and wastewater treatment were 334 MT CO_2e in 2010 and 325 MT CO_2e in 2018, less than 1% of total emissions for both inventory years. Water and wastewater emissions refer to Frederick County's sewer system emissions and nitrous oxide (N_2O) effluent discharge emissions. The figures shown here do not include emissions arising from energy use at the County's wastewater treatment facilities; those emissions are included as Buildings and Energy Use emissions above. In 2018, water and wastewater treatment facilities accounted for 52% of government operations electricity consumption; electricity consumption at these facilities alone contributes 20% of the County's overall emissions. Similarly, process and fugitive emissions amounted to 346 MT CO_2e in 2010 and 338 MT CO_2e in 2018; also, less than 1% of total emissions for both inventory years.

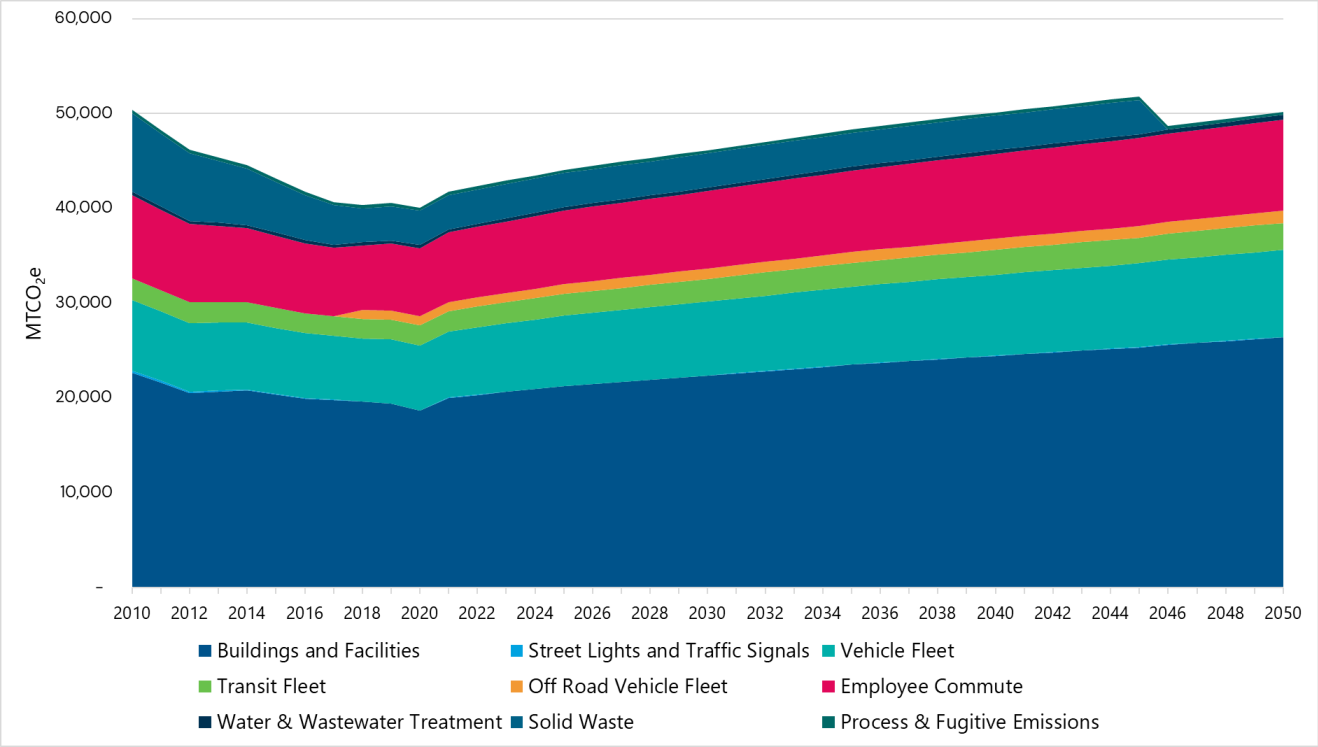
[10] Off Road Vehicle emissions for 2010 are incorporated into Vehicle Fleet emissions, as this data was not broken out.

2.4 Projections: 2019 to 2050

COG developed BAU projected emissions for 2019 to 2050 to serve as a baseline against which to measure the impact of the County's strategies to reduce emissions over the next decade. The BAU scenario shows trends in the County's GHG emissions under current conditions without factoring in the State of Maryland's Renewable Energy Portfolio Standard (RPS) or the implementation of any additional activities and/or policies to reduce GHG emissions, such as energy efficiency measures, renewable energy credits (RECs), or otherwise. COG also developed Reference Case projected emissions for 2019 and 2050. The Reference Case projections are the same as the BAU scenario, except that it factors in the state RPS through to 2050, thus emissions are lower through 2050. Projected electricity estimates in the BAU scenario assume that the regional electricity grid does not change in the future (i.e., the estimates do not account for any increased use of renewable energy for electricity generation or shifts away from coal to less carbon-intensive fossil-based generation sources such as natural gas). The Reference Case scenario assumes that Maryland meets the state RPS. It should be noted that Maryland does not currently meet this standard, and compliance fees are paid in lieu of meeting the RPS.

As the County population grows, the operations of County government (and emissions resulting from those activities) are likely to increase to meet the needs of the community. As a result, projections for most emission sources are based on projected County population estimates from COG's Cooperative Forecast.[11] These population estimates were used to scale activity data (e.g., energy consumption in County buildings and facilities, fuel use in County vehicles, as well as water and wastewater treatment). This method is commonly used to project emissions from government operations. Figure 10 shows the Reference Case GHG emission projections by source through 2050, as well as a dashed line representing the BAU scenario emissions (i.e., higher emissions without inclusion of the state RPS).

Figure 10: 2010 through 2050 Reference Case Emissions by Source with BAU Projections



[11] COG's 9.1a Cooperative Forecast. See https://www.mwcog.org/documents/2021/12/02/cooperative-forecasts-employment-population-and-household-forecasts-by-transportation-analysis-zone-cooperative-forecast-demographics-housing-population/

Frederick County's overall GHG emissions from government operations are projected to decrease by just under half a percent from 50,360 MT CO_2e in 2010 to 50,196 MT CO_2e in 2050 under the BAU scenario (see Table 2). Between 2010 and 2018, total County emissions decreased by 20%. The projections show emissions dropping to the year 2020, before slowly increasing again. The driver of growth in emissions between 2020 and 2050 is County population growth, which will likely increase demand for County services and is anticipated to result in expanded operations. Buildings and facilities energy consumption increase 16%, largely driven by increased electricity usage and no changes in the grid fuel mix. Also, there is an assumption that the County's landfill will stop receiving solid waste deliveries at the end of its life, which is projected to be in 2045. All sources are projected to increase GHG emissions from 2010 to 2050, except streetlights and traffic signals, and solid waste.

Table 2: 2010 to 2050 Projected BAU GHG Emissions by Source

Emissions Source / Sector	Emissions (MT CO_2e)						% Change 2010-2050
	2010	2018	2020	2030	2040	2050	
Buildings and Facilities	22,665	19,603	18,648	22,352	24,455	26,396	16%
Streetlights and Traffic Signals	253	36	34	41	45	48	-81%
Vehicle Fleet (including Off-Road Vehicles)	7,419	7,571	7,812	8,856	9,689	10,458	41%
Transit Fleet	2,252	2,049	2,117	2,400	2,625	2,834	26%
Employee Commute	8,799	6,837	7,206	8,169	8,938	9,647	10%
Water & Wastewater Treatment	334	325	336	380	416	449	34%
Solid Waste	8,292	3,589	3,589	3,589	3,589	-	-100%
Process & Fugitive Emissions	346	338	340	349	356	363	5%
Total GHG Emissions	**50,360**	**40,349**	**40,081**	**46,137**	**50,115**	**50,196**	**-0.3%**

Table 3: 2010 to 2050 Projected Reference Case GHG Emissions by Source

Emissions Source / Sector	Emissions (MT CO_2e)						% Change 2010-2050
	2010	2018	2020	2030	2040	2050	
Buildings and Facilities	22,665	19,603	17,594	15,610	16,791	17,880	-21%
Streetlights and Traffic Signals	253	36	32	27	29	30	-88%
Vehicle Fleet (including Off-Road Vehicles)	7,419	7,571	7,812	8,856	9,689	10,458	41%
Transit Fleet	2,252	2,049	2,117	2,400	2,625	2,834	26%
Employee Commute	8,799	6,837	7,206	8,169	8,938	9,647	10%
Water & Wastewater Treatment	334	325	336	380	416	449	34%
Solid Waste	8,292	3,589	3,589	3,589	3,589	3,589	-57%
Process & Fugitive Emissions	346	338	340	349	356	363	5%
Total GHG Emissions	**50,360**	**40,349**	**39,025**	**39,381**	**42,434**	**45,251**	**-10%**

In contrast to the BAU scenario, under the Reference Case scenario Frederick County's overall GHG emissions from government operations are projected to decrease by 10% from 50,360 MT CO_2e in 2010 to 42,251 MT CO_2e in 2050 (See Table 3). This decrease is driven solely by decreases in emissions from electricity consumption due to the state RPS, which sets a target of 50% for the share of the state's energy generation that comes from renewable energy sources by 2030. Beyond 2030, emissions from electricity begin to steadily increase, as the RPS target (50% renewable energy generation) is held constant through 2050. Once again, County population growth drives the increase in emissions. Despite a projected increase in energy consumption, the cleaning of the grid's fuel mix results in a 21% reduction in emissions arising from buildings and facilities.

As seen in Table 2 and Table 3, all projections in the BAU and Reference Case scenarios are calculated according to the same methodology and result in the same projected emissions by 2050. Emissions from stationary fuel use increase by 21% between 2010 and 2050 (2,673 MT CO_2e to 3,233 MT CO_2e). All transportation emission sources are anticipated to grow in line with population growth by 2050 from 18,469 MT CO_2e in 2010 to 22,939 MT CO_2e in 2050, as demand for vehicle and equipment usage and the number of employees commuting increase with County operations. Emissions from on-road vehicles and off-road vehicles and equipment are projected to be 41% higher in 2050, while emissions from the transit fleet are projected to be 26% higher in 2050. Employee commuting emissions are projected to be 10% higher in 2050.

Emissions from solid waste disposal decrease by 57% between 2010 and 2018, from 8,292 MT CO_2e to 3,589 MT CO_2e. Emissions were held constant from 2018 to 2045, as the County landfill only receives waste for two weeks each year and it is assumed that this will stay relatively constant through to 2045. Beyond 2045, it is assumed that there are no further solid waste deliveries to the landfill and emissions cease.

Water and wastewater treatment emissions increase 34% between 2010 and 2050, in line with population growth projections. Possible expansion of wastewater treatment facilities would also drive building energy use emissions higher. Process and fugitive emissions increase by 5% between 2010 and 2050. This is mostly driven by fugitive natural gas emissions, as emissions from HFCs are kept constant through 2050.

Overall, the County government's BAU GHG emissions trends through 2050 shows a slight increase due to expanding government operations with population growth. The projections would result in a moderate increase by 2050 if the County landfill continued to accept waste through 2050. The Reference Case GHG emissions trends through 2050 show a moderate decrease in emissions, largely driven by the state RPS cleaning up the electricity grid.

3 Climate Mitigation Scenario Analysis and Strategies

GHG mitigation involves reducing and/or avoiding GHG emissions to limit contributions to climate change. This chapter provides an overview of twelve strategies that the County can take to reduce emissions from County government operations across three sectors: Buildings and Energy Use, Transportation, and Waste. These sectors represent the largest portion of the County government's emissions (as discussed in the previous chapter), over which the County government has the ability to implement changes to reduce GHG emissions.

In 2020, the Frederick County Council adopted a Climate Emergency Resolution in which the County resolved to "commit to equitable climate emergency mobilization efforts to address global warming, reduce County-wide greenhouse gas emissions 50% from 2010 levels by 2030 and 100% no later than 2050, and employ efforts to safely drawdown carbon from the atmosphere." As an initial part of this effort, the County established an independent citizen-based Climate Emergency Mobilization Workgroup to make recommendations to achieve emission reduction goals. This document indicates where there is overlap between the County's strategies and those developed by the Workgroup.

Key Findings

This GHG mitigation analysis identified priority strategies to reduce GHG emissions from County government operations. **The strategies with the highest potential to reduce GHG emissions by 2030 include:**

- Procuring **100% renewable electricity**
- **Electrifying the County government's vehicle fleet**

This chapter presents the following information:

- **Overview**: Provides a summary of the mitigation strategies that were identified and modeled for this CEAP and describes the information provided in each strategy discussion.
- **Mitigation Strategy Results**: Describes the overall GHG reductions anticipated from the mitigation strategies included in the CEAP.
- **Strategies by Sector**: Provides an in-depth description of each strategy in the Buildings and Energy Use, Transportation, and Waste sectors.

3.1 Overview

This section describes actions the County **can take to reduce its GHG emissions from government operations** over the coming decade. These strategies build on the County's current activities and initiatives. Each strategy includes an estimate of the GHG reduction benefits through 2050, financial impacts, and key considerations for implementing the strategy, including next steps.

The list of actions in this CEAP **expands on current and planned actions by the County** and includes additional GHG reduction strategies that will further reduce government emissions from the BAU scenario described in the previous chapter. These actions were developed through conversations with key stakeholders internal to the County (e.g., fleet and facilities managers) and COG. The list was further refined using criteria including alignment with County priorities, available resources, costs, and ease of implementation. The actions

focus mainly on the energy and transportation sectors because they offer the largest emission reduction opportunities for the County.

Table 4 lists the GHG reduction strategies included in this CEAP for the building and energy use, transportation, and waste sectors. The table also identifies the GHG and other reduction benefits associated with each strategy. The Buildings and Energy Use and Transportation strategies in Table 4 are included in the GHG emission reductions modeling summarized in Section 3.2. The GHG reductions from the Waste sector strategies are not included in the estimate of emission reductions due to the scope of emissions impacted (i.e., the majority of the County's waste is disposed of outside of the County's boundaries, and is therefore considered an indirect Scope 3 source of emissions and not included in the GHG inventory presented in this CEAP).

Table 4: Recommended Mitigation Strategies with Co-Benefits

	Reduces:				**Supports Transition To:**	
Mitigation Strategy	Electricity Use	Natural Gas Use	Mobile Fuel Use	Waste Generation	Renewable Energy	Cleaner Mobile Fuels
Buildings and Energy Use						
E1 Renewable Energy Procurement					✓	
E2 Low-Carbon Gas		✓				
E3 Green Building Standards	✓	✓				
E4 Building Energy Efficiency	✓	✓				
E5 Building Electrification		✓				
Transportation						
T6 Electric Vehicle Adoption						✓
T7 Hybrid Replacement Program						✓
T8 Diesel to Biodiesel Conversion						✓
T9 Telecommuting			✓			
Waste						
W10 Increase County Waste Diversion				✓		
W11 Reduce County Employee Waste Generation				✓		
W12 Sustainable Purchasing and Procurement				✓		

E = Energy, T = Transportation, W = Waste

3.2 Mitigation Strategy Results

This CEAP recommends and outlines **twelve mitigation strategies** across the Buildings and Energy Use, Transportation, and Waste sectors. Of these, ICF modeled emission reductions for nine of the strategies across the Energy and Transportation sectors. Emission reductions for Waste strategies were not modeled because they impact emissions from waste disposed outside of the County; however, this chapter still includes the three recommended waste strategies and their potential impacts on emissions and cost. Overall, the implementation of the nine modeled Energy and Transportation strategies will result in GHG emissions that are 60% lower than 2010 levels in 2030 and 56% lower than projected 2030 emissions under the BAU scenario for Frederick County—enabling the County to meet its GHG reduction goal for 2030. After implementing these strategies, the County is projected to emit 20,165 MT CO_2e in 2030 compared with BAU scenario emissions (i.e., if no additional mitigation actions were implemented) of 46,137 MT CO_2e in 2030 as shown in Table 5.

Table 5: Comparison of 2010 and 2018 Emissions with Projection Scenarios in 2030

Emissions Source / Sector	Emissions ($MT CO_2e$)			
	2010 Baseline	2018 Progress	2030 BAU	2030 With Mitigation
Building and Energy (including Streetlights)	22,918	19,639	22,393	1,567
On-Road Vehicle, Transit, and Off-Road Fleet	9,671	9,621	11,256	8,152
Employee Commute	8,799	6,837	8,169	6,127
Water & Wastewater Treatment	334	325	380	380
Solid Waste	8,292	3,589	3,589	3,589
Process & Fugitive Emissions	346	338	349	349
Total GHG Emissions	**50,360**	**40,349**	**46,137**	**20,165**

Estimated emission reductions compared to the BAU from full implementation of the mitigation strategies by sector are shown in Table 6 for 2030, 2040, and 2050. Strategies targeting the Building and Energy Use sector account for 80% of GHG emission reductions in 2030 and Transportation sector strategies account for the remaining GHG emission reductions.

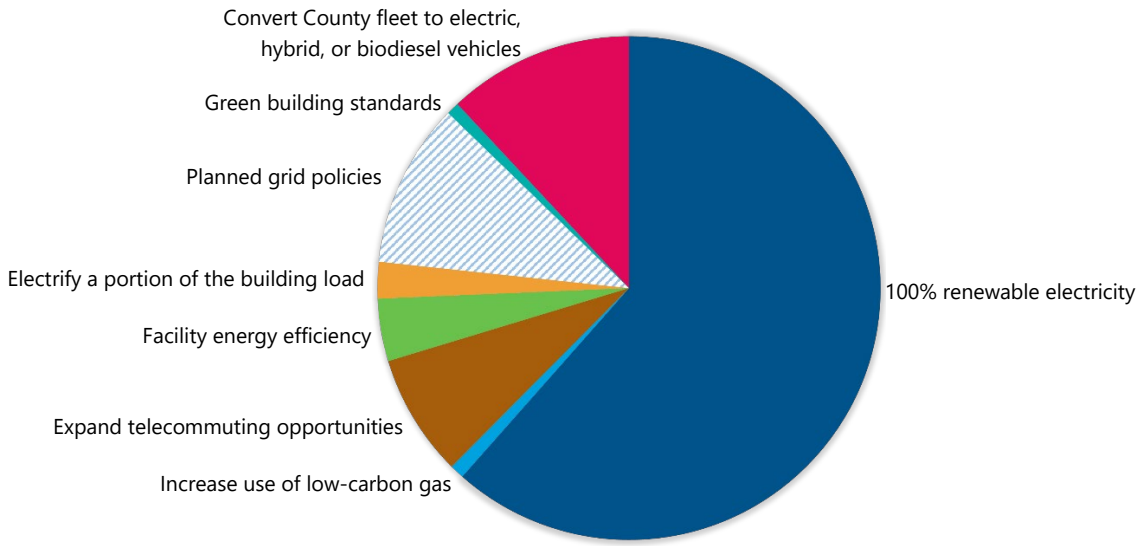
Table 6: Emissions Reductions from BAU Levels by Sector and Mitigation Strategy through 2050

Mitigation Strategy	Emission Reductions ($MT CO_2e$)		
	2030	2040	2050
Building and Energy Use	**20,826**	**23,499**	**25,395**
100% renewable electricity	15,980	17,225	18,330
Increase use of low-carbon gas	239	239	239
Green building standards	211	533	823
Building energy efficiency	1,042	1,892	1,868
Electrify a portion of the building load[1]	610	1,084	1,084
Planned grid policies[2]	*2,743*	*2,525*	*3,049*
Transportation	**5,146**	**7,468**	**9,346**
Electrify the County fleet[1]	1,631	4,479	6,860
Adopt a hybrid replacement program	1,423	701	16
Convert diesel fleet to biodiesel	49	54	58
Expand telecommuting opportunities	2,042	2,235	2,412
Total Emission Reductions	**25,972**	**30,967**	**34,740**

[1] Electrification strategy assumes the purchase of 100% renewable electricity for the additional demand.
[2] Planned grid policies are based on the Reference Case scenario that assumes that Maryland meets the state RPS. No action by the County is necessary for these reductions.

The strategy that will reduce GHG emissions the most is the procurement and production of 100% renewable energy. This strategy (including the reductions from additional electricity used from the electrification of vehicles and buildings) accounts for 62% of projected emission reductions in 2030. As a result, the implementation of this strategy will have a substantial impact on the GHG emission reductions that the County can feasibly achieve. Other strategies with significant potential to reduce GHG emissions include electrifying the County fleet, expanding telecommuting opportunities, adopting a hybrid replacement program, and increasing building energy efficiency. Figure 11 shows the total impact of various mitigation strategies by sector.

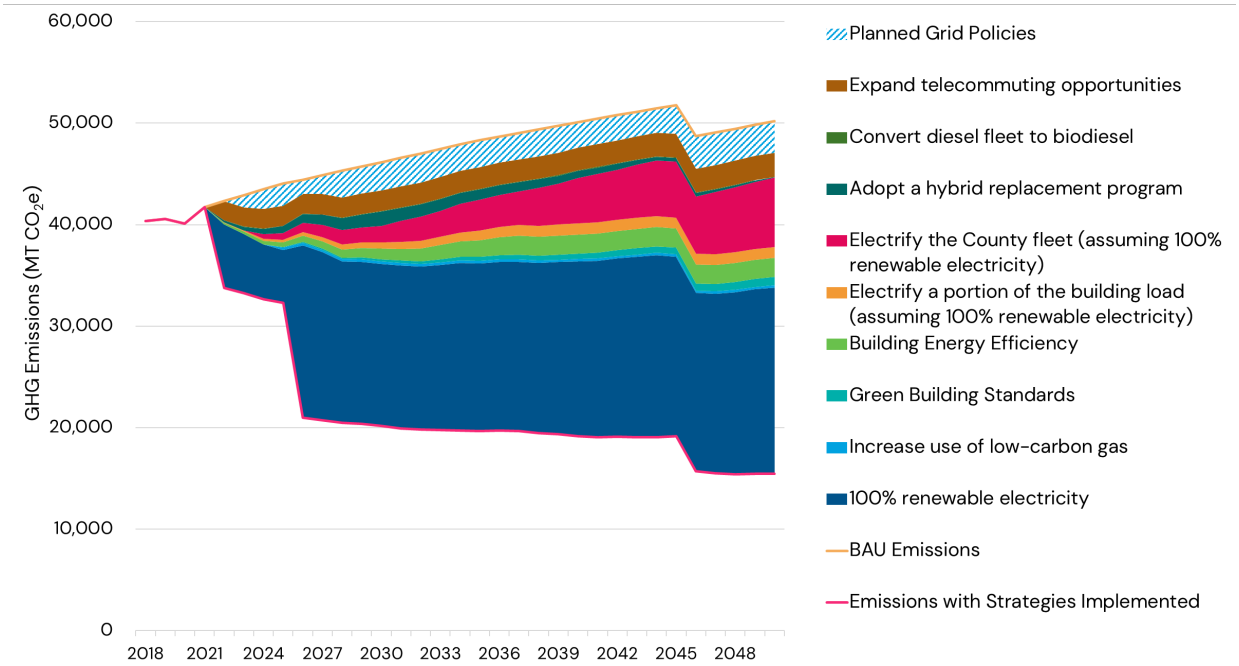
Figure 11: Mitigation Strategies to Achieve 25,972 MT CO_2e Emissions Reductions by 2030



By implementing the mitigation strategies outlined in this plan, the County will reduce its operational GHG emissions by 69% (34,740 MT CO_2e) from the BAU scenario resulting in 15,456 MT CO_2e, compared to 2050 BAU levels of 50,196 MT CO_2e. **This plan lowers GHG emissions in the building and energy use sector by approximately 95% by 2050.** This is largely driven by the purchase of 100% renewable electricity, which accounts for more than half of total GHG reductions under the mitigation scenario across all sectors, including the additional renewable electricity purchased as part of the building and vehicle electrification strategies. On-site stationary fuel combustion emissions are projected to decrease by 40% in the 2050 mitigation scenario compared to 2010 emissions due to energy efficiency measures and green building standards.

Emissions from the **transportation sector are also projected to decrease by 26% by 2050 compared to 2010 levels**. Given projected growth in the transportation sector under the BAU scenario, emission reductions from mitigation strategies will result in transportation emissions that are 41% lower in 2050 than BAU conditions. Figure 12 shows the accruing impact of GHG reduction strategies through 2050, compared to BAU.

Figure 12: Greenhouse Gas Reductions by Mitigation Strategy versus BAU Scenario



After accounting for GHG reductions from mitigation strategies included in this plan, the largest source of projected emissions in 2030 will be the transportation sector (including County fleet and employee commuting), amounting to 71% of total emissions. Transportation emissions are followed by waste emissions, comprising 20% of remaining emissions in the mitigation scenario in 2030. Emissions from the waste sector are projected to be 100% lower in 2050 compared to 2010 levels. This is due to the retirement of the County landfill in 2045. Table 7 lists the projected emissions by source with mitigation strategies implemented.

Table 7: 2010 to 2050 Projected GHG Emissions by Source with Mitigation Strategies Implemented

Emissions Source / Sector	Emissions (MT CO_2e)						% Change
	2010	2018	2020	2030	2040	2050	2010-2050
Building and Energy Use (including streetlights)	22,918	19,639	18,682	1,567	1,001	1,050	-95%
On-Road Vehicle, Transit, and Off-Road Fleet	9,671	9,621	9,928	8,152	7,082	6,358	-34%
Employee Commuting	8,799	6,837	7,206	6,127	6,704	7,235	-18%
Water & Wastewater Treatment	334	325	336	380	416	449	34%
Solid Waste Disposal	8,292	3,589	3,589	3,589	3,589	0	-100%
Process & Fugitive Emissions	346	338	340	349	356	363	5%
Total GHG Emissions	**50,360**	**40,349**	**40,081**	**20,165**	**19,148**	**15,455**	**-69%**

3.3 Strategies by Sector

3.3.1 Buildings and Energy Use

GHG mitigation strategies under this sector aim to reduce GHG emissions related to energy use in County-owned buildings. The first strategy, renewable energy procurement, reduces GHG emissions through the purchase of 100% renewable electricity and supports robust emission reductions when combined with building and transportation electrification strategies. The second strategy explores the use of low-carbon natural gas, called renewable natural gas (RNG), to reduce emissions at a large and difficult to decarbonize facility. The third strategy seeks to implement green building standards that will ensure that investments in new construction and major renovation projects reflect the County's carbon emissions reduction goals. The fourth strategy implements an energy management database which will allow the County to improve their understanding of their energy needs, help track progress towards energy reduction goals, and pinpoint areas for improvement. It also seeks to implement energy efficiency in buildings to reduce GHG emissions by reducing the amount of energy consumed by County-owned facilities. The last strategy in this section seeks to implement building electrification strategies, allowing building energy use to be powered by carbon-free renewable electricity.

The **five strategies** in this sector will reduce overall GHG emissions by 20,826 MT CO_2e by 2030 and 25,395 MT CO_2e by 2050. Table 6 shows the projected emission reductions from each strategy. The largest contributing mitigation strategy for building and energy use is the 100% renewable energy procurement (accounting for 72% of emission reductions), followed by increasing building energy efficiency (7% of reductions) and then electrifying a portion of the building load (4% of reductions).

Sector Overview

Frederick County has long worked to manage energy use, publishing comprehensive energy plans as early as 2010. The most recent Comprehensive Energy Plan, from April 2021, outlines a set of investments and work aimed at achieving monetary savings and creating environmental benefits. Many of the recommendations from that document overlap with strategies and goals from this CEAP. The Comprehensive Energy Plan also outlines previous work completed by the County, including an onsite solar power purchase agreement (PPA) at a County

landfill and energy efficiency investments. Together, that plan and previous work demonstrate the leadership that Frederick County is already demonstrating in managing energy procurement and energy use in its facilities.

Facility Operations and Capital Improvements

Frederick County runs a sophisticated operations and maintenance program for its facilities. Its facility maintenance group is responsible for a large set of work in-house including full renovations of facilities and the installation of new HVAC and electrical systems in buildings. Their work already includes a variety of energy efficiency and electrification scopes in alignment with the 2021 Comprehensive Energy Plan for County Government and are well governed to expand their work to include additional energy-related projects, including capital projects, new building automation systems (BAS) and energy efficiency installations as outlined in the strategies listed here. BAS provide opportunities to significantly reduce energy consumption of buildings, but by controlling equipment to optimize the hours and ways that they heat and cool facilities. In 2022, the County bolstered their BAS work by hiring a dedicated controls technician, who is working to inventory and expand their systems. The County has worked to design to energy efficiency into their new buildings and major renovations, but does not have energy efficiency standards for these projects.

Key Terms for Energy Procurement

RECs: Renewable Energy Certificates are a market-based instrument that represents the property rights to the environmental, social, and other non-power attributes of renewable electricity generation. They can be conveyed as either associated with physical electricity supply (bundled), or not (unbundled) and are available from various locations (National, regional, or state based), renewable fuel types, and vintages.

PPA: Power Purchase Agreements are a common method of installing onsite renewables where a project developer arranges for the design, permitting, financing and installation of a system on a property at little to no cost. These can be located onsite or offsite

FACT: The Frederick Area Cooperative Team is a group of Frederick County Government, Frederick County Public Schools, and Frederick Community College.

PJM: PJM is the electricity and grid operator for the greater Mid-Atlantic region. They have a 13-state footprint and operate the electricity and REC markets in Maryland. The County, in collaboration with FACT, purchases electricity through a PJM-Subaccount, allowing them direct access to the market via an electricity supplier.

ADD definition of RPS

Energy Procurement

Frederick County takes a strategic approach to electricity procurement using a PJM subaccount to purchase energy blocks and manage cost and risk associated with electricity. This work is done in collaboration with the Frederick Area Cooperative Team (FACT), with members including Frederick County Government, Frederick County Public Schools, and Frederick Community College. Additionally, beginning in Fiscal Year 2022, the County purchased RECs to match building electricity use for its general buildings and facilities. The County also has several onsite solar photovoltaic installations that are collocated at its facilities including a TESLA-owned array at the Reich Ford Road Landfill, a recently constructed County-owned array at the Ballenger-McKinney Wastewater Treatment Plant, and a solar water heater facility at the County Detention Center. The landfill facility produces renewable energy credits (RECs) which are purchased from TESLA at a rate guaranteed by contract through 2025 and will be sold to FACT beginning calendar year 2022; this purchase will meet FACT's Renewable Portfolio Standard (RPS) for Maryland SRECs until the end of the existing contract in 2026. Additional SRECs generated over the amount needed for the RPS will be purchased from TESLA and managed in the County's account on the PJM GATS trading platform. The wastewater treatment plant's RECs, which was recently brought online will be similarly integrated into the County's compliance with Maryland's RPS.

The County's existing electricity supply contract has allowed it to stay grandfathered into lower renewable energy procurement amounts. When the contract expires and a new contract is put in place, the County and other members of FACT will need to purchase a significant amount of RECs to stay in compliance with Maryland's RPS. The Maryland's RPS requires that 50% of electricity come from renewable sources by 2030. In 2026, shortly after the existing contract expires, the County will need to procure 42.5% of its electricity from Tier I RECs such as solar and wind. If FACT were required to meet this requirement in 2022, it would cost an additional $287,000 based on REC pricing from the November 2021 quarterly electric supply report. The County's status with an existing contract has saved them $569,000 over the three years from 2019 through 2021. In 2025, the County's FACT energy contract will expire, its contract with TESLA guaranteeing the SREC price will expire. The County will need to develop a strategy to meet its RPS and address its goals for clean energy procurement.

Energy Data Management

Frederick County tracks energy data through utility bills with a primary focus on costs and payment. This approach means that data on energy use and demand for electricity, natural gas, and other fuels is not continuously tracked and it is difficult to understand how energy use might be changing in facilities. The County is in the process of adding a utility bill system for electricity which will scan utility bills, integrate with ENERGY STAR® Portfolio Manager, create usage alerts, and flag billing and payment issues.

The County does annually benchmark facilities energy use with ENERGY STAR® Portfolio Manager, which helps to identify building inefficiencies and energy project opportunities. The County also operates a variety of building automation systems BAS at facilities which operate, and schedule, HVAC systems, and is working to centrally manage data from these facilities. With changes to BAS, including tighter scheduling, optimizing ventilation and other operational changes, the County could realize significant energy and cost savings.

Description of climate actions

The five strategies modeled for mitigating building and energy use emissions are:

Mitigation Strategy	Strategy Description
Strategy E1: Renewable Energy Procurement	100% renewable electricity procurement or production for all facilities.
Strategy E2: Low Carbon Gas	Procurement of renewable natural gas for a pilot project.
Strategy E3: Green Building Standards	Institute Green Building Standards for new construction and major renovations.
Strategy E4: Energy Management Database and Building Energy Efficiency	Implement an energy management database to better understand facility energy use and energy project opportunities. Implement energy efficiency in buildings to reduce GHG emissions and meet state building performance standards over time.
Strategy E5: Building Electrification	Implement building electrification measures at County facilities.

Guide to Strategy Overviews

Each strategy includes a summary box highlighting key outcomes of the strategy, including relative GHG emission reduction benefits, anticipated GHG emission reductions in 2030 and 2050, and financial impacts—including upfront costs and ongoing costs or savings. Relative impacts of strategies are designated as follows:

Relative GHG Reduction Scale	Relative Financial Impact Scale	
Relatively low GHG reduction	$ Relatively low cost	$ Relatively low savings
Medium GHG reduction	$$ Medium cost	$$ Medium savings
Highest GHG reduction	$$$ Relatively high cost	$$$ Relatively high savings

Key assumptions for the mitigation strategies can be found in Technical Appendix B: Mitigation Analysis Assumptions and Methods: 9.1 Buildings and Energy Use Strategies.

Strategy E1: Renewable Energy Procurement

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 15,980 MT CO_2e **2050** 18,330 MT CO_2e	$$ Consulting support for the transaction	DEE Procurement & Contracting	Amount purchased will be impacted by electrification strategies that increase electricity demand (e.g., electrifying buildings, vehicles) or decrease electricity demand (e.g., energy efficiency, green building standard).
Co-Benefits	**Ongoing Savings**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Aligns with state RPS requirements.	$ Will reduce or stabilize costs over the life of the investments	FACT, BRCPC, Water and Sewer, Solid Waste, Potomac Edison	Accelerate solar deployment.

Through this strategy, the County would purchase 100% of electricity from renewable sources to include renewable energy credits (RECs) and offsite and onsite power purchase agreements (PPAs). This strategy considers changes to electricity use from other strategies including building measures and fleet electrification. The strategy targets 100% renewable electricity starting in 2026 through onsite generation, offsite PPAs, and REC purchases and maintains it through 2050 as the load continues to increase due to building and transportation electrification. Over time, the County would incorporate PPAs either through the Frederick Area Cooperative Team (FACT) or in collaboration with other jurisdictions regionally (e.g., Baltimore Regional Cooperative Purchasing Committee [BRCPC]). The strategy recommends prioritizing the expansion of local generation in alignment with Maryland RPS requirements.

The County's current approach allows the County to offset GHG emissions from its electricity use with a nominal cost, however it does not protect the County from future energy price risks, provide local benefits to the County, or provide a strategic approach to compliance with Maryland's RPS.

The County needs a strategic policy and plan for renewable energy procurement to allow its electricity procurement program to not only support cost goals, but also environmental and climate mitigation concerns. When FACT's current contract expires in 2026, the County will lose its grandfathered status on Maryland RPS requirements and will be required to purchase significant volumes of RECs. Instead of accepting these costs, the County can review renewable energy procurement options which have the potential to stabilize or reduce electricity costs. A strategic policy would include a review of how existing solar projects are using and selling RECs, and a review of energy procurement options that would help the County save money. Strategy should consider available options, beyond just their ability to lower costs, such as their complexity, and their local benefits such as air quality and economic development. Cost evaluation should closely evaluate those costs associated with meeting Maryland RPS requirements over time. An updated renewable energy procurement strategy would include the use of PPAs both at County facilities and at large offsite locations to purchase significantly more renewable electricity. An updated strategy will also allow the County to gain a myriad of other benefits such as more local economic opportunities and local environmental benefits. The County has three large categories of renewable energy procurement from which to source RECs and renewable electricity:

Maryland's RPS

Maryland's Renewable Portfolio Standard (RPS) applies to:

A. All suppliers that sell electricity at retail in Maryland; and.

B. Any renewable energy facility participating in the Renewable Energy Portfolio Standard Program.

The current RPS required 50% of electricity to come from regional renewable sources by 2030. As consumers of electricity, the County's supplier is required to purchase renewable electricity to meet the RPS. These purchases come at a significant cost, and can be managed through a strategy REC policy.

- **Purchase of unbundled RECs:** The County currently purchases unbundled national RECs on a voluntary basis to support climate and sustainability in the County. These RECs are low cost and are not eligible for Maryland RPS since they are sourced from locations outside of Maryland. The County also purchased local (PJM regional) RECs for compliance with the existing Maryland RPS through their PJM subaccount.
- **Supplier-led renewable energy procurement:** The County could, in alignment with its electricity supplier, pursue renewable energy procurement as part of its electricity supply contract. Using this approach, the County could stabilize costs over the term of its supplier agreement and potentially support new local renewable energy projects.
- **Onsite Solar or Onsite Solar PPA:** The County also generates RECs from an onsite owned solar installation and from its onsite solar PPA. Future onsite projects offer potential to generate renewable energy and associated RECs. In Maryland, the County could perform net metering across facilities within a certain distance, allowing large solar PV projects (up to 2MW) to potentially provide electricity to multiple facilities in the County. This transaction has the potential to lower costs.
- **Offsite PPA:** The County could pursue an offsite PPA (either solar or wind) in Maryland which could provide RECs and electricity to the County's PJM subaccount through a negotiated contract. This transaction has the potential to lower costs. Offsite procurements would be best completed in partnership with other large entities (such as BRCPC) to maximize economies of scale and provide lower cost electricity.

Using PPAs, and specifically offsite PPAs, would provide the potential for the County to not only increase their renewable electricity purchasing, but also reduce costs and energy price risk. Executing large PPAs, and particularly offsite PPAs, requires significant upfront work by the County. To complete an offsite project, the County would need to work closely with partners to determine how a new set of goals fit with their operation's members of both FACT and BRCPC, all of whom will be facing similar challenges. If the County were to pursue offsite projects, they could do so as the leader of a standalone procurement for FACT, in collaboration with FACT partners, or as an add-on to a renewable energy procurement from BRCPC. Partnerships are needed to support the complex transactions and the scale needed to ensure low-cost electricity. Through the PJM subaccount, there are several ways to integrate renewable electricity procurement including a physical supply PPA or a virtual PPA.

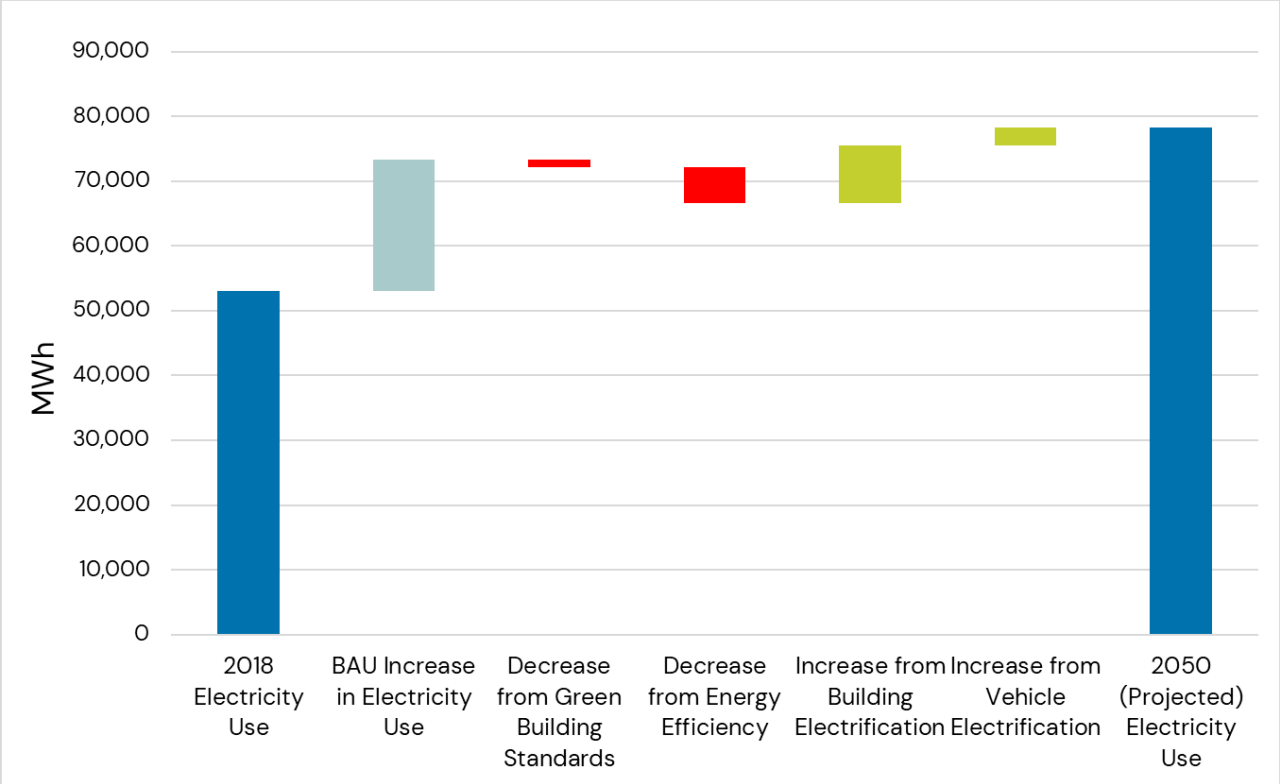
In addition to offsite projects, the County should continue to pursue onsite solar installations, however given the size and scale of the County's operations, onsite solar projects will likely only make up a portion of the County's operational needs. As an example of this challenge, in 2012 Frederick County worked on a Solar Feasibility Study for its facilities. The study identified three sites for solar, and the implementation of 424 kW. These projects, if installed today, would still require significant resources and work to complete, however together they would provide less than 1% of electricity needs for the County's portfolio. Still, opportunities exist to aggregate multiple sites (both County-owned and non-County-owned), that can provide electricity to County facilities. This approach was recently implemented by nearby Howard County, which has a hybrid approach to onsite/offsite power procurement agreements.[12]

Lastly, to meet a 100% renewable energy goal, it is likely that some portion of unbundled RECs will need to be purchased to balance the County's changing electricity demand on a year-to-year basis. Since unbundled RECs will always have an additional cost, the purchasing of RECs should be done last.

As this work is pursued, the County will need to carefully track their electricity use to ensure that electricity use increases (from building electrification, County growth, and/or vehicle electrification) and electricity use reductions (from energy efficiency, County policies on green buildings) are fully accounted for. In the modeling completed, electricity use is expected to increase from 52,983 MWh in 2018 to 82,952 MWh is 2050, based on the BAU forecast and the implementation of the various strategies covered in this document and outlined in Figure 13.

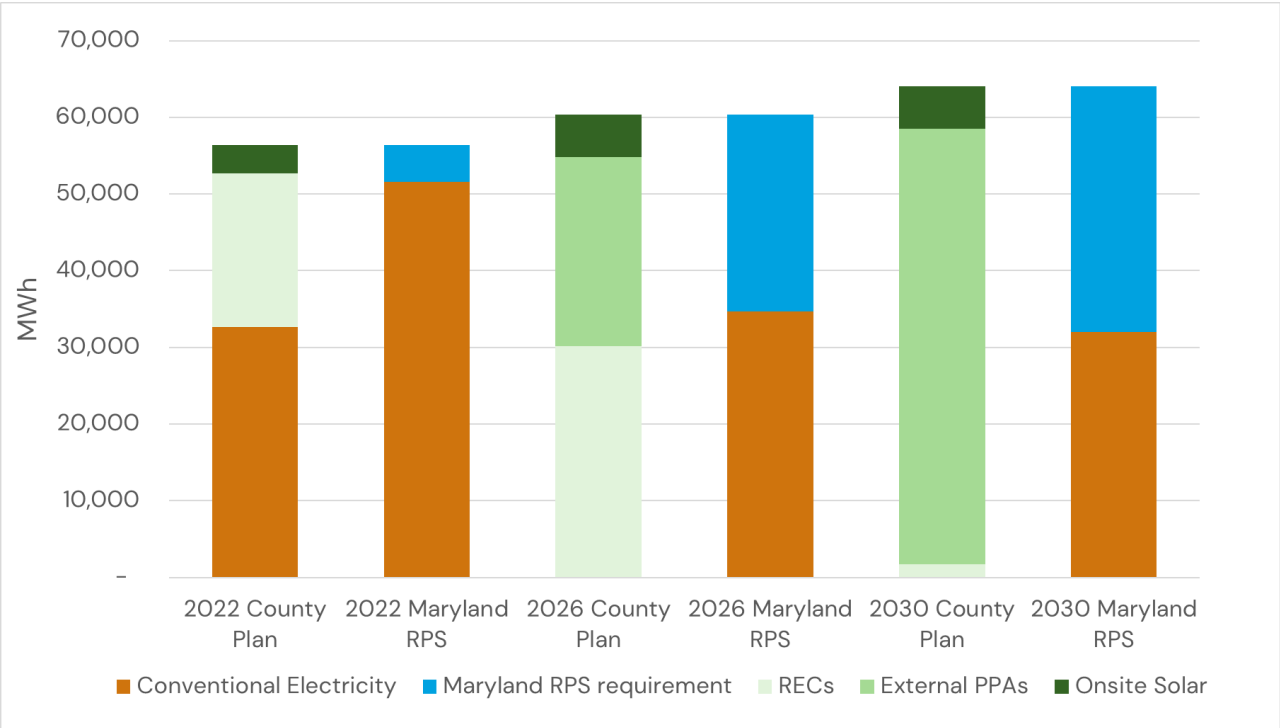
[12] Howard County Executive Calvin Ball Announces Solar Power Purchasing Agreement (2020) https://www.howardcountymd.gov/environment-community-sustainability/honor-earth-day-howard-county-executive-calvin-ball-announces

Figure 13: Projected Electricity Use Changes from Modeled Mitigation Strategies



Through this strategy, Frederick County will see a transformation of how it purchases electricity as illustrated in Figure 14. In 2022, a mix of onsite solar and RECs provide approximately 42% renewable energy, compared to the Maryland RPS requirement of 8.5% for Frederick County. By 2030, 100% of the County's electricity will be from renewable sources, with the majority from offsite PPAs.

Figure 14: County Renewable Electricity Plans and Maryland RPS Requirements, 2022, 2026, and 2030



Anticipated GHG Reductions

Through this strategy, in alignment with other electrification strategies, an estimated 22,827 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario. Excluding the reductions from the additional electricity of building and vehicle electrification strategies, this strategy will reduce an estimated 18,330 MT CO_2e annually by 2050.

Relative Costs to Implement

Exact costs were not estimated for this strategy, as market prices for conventional electricity, renewable electricity and RECs are highly variable, however a growing trend of cost-effective and risk-mitigating renewable energy procurements by local governments demonstrates the cost and technical feasibility of project implementation.[13] This strategy should focus on low-cost solutions and will likely need some professional consulting support in addition to the PJM subaccount support already provided to the County. The County should pursue RECs which help meet the compliance needs of the Maryland RPS first, which reduce cost risks to the County by creating stable pricing for RECs. An overview of the various types of procurement and their relative costs and benefits are outlined in Table 8.

Table 8: Overview of Renewable Energy Procurement Types, Relative Costs, Complexity and Benefits

	Unbundled RECs (National)	Unbundled RECs (Local)	Supplier Led Renewable Energy Procurement	Onsite PPA (RECs held or swapped)	Offsite PPA (RECs held or swapped)
Lowers Cost	No	No	Maybe	Maybe	Maybe
Offsets GHGs	Yes	Yes	Yes	Yes	Yes
Integration with PJM Subaccount	Maybe	Yes	Yes	N/A	Yes
Local Generation and Air Quality Benefits	No	Maybe	Maybe	Yes	Maybe
Avoids Changes to Existing Buildings	Yes	Yes	Yes	No	Yes
Accelerates Local RE Economic Development	No	Maybe	Maybe	Yes	Maybe
Complexity	Easier	Easier	Difficult	Difficult	Most Difficult

N/A: Not Applicable

Based on the table above, offsite PPAs or supplier-led renewable energy procurements offer the best option due to both their many benefits and their overall scale. As outlined above, offsite projects are among the most challenging to implement and the County will need partners (FACT, BRCPC) to get to projects large enough to meet cost effectiveness hurdles. As an alternative to an offsite PPA, the County could pursue supplier-led renewable procurement, where an electricity supplier instead seeks offsite renewable energy agreements that meet the County's goals.

[13]Local Government Renewables Action Tracker, World Resources Institute 2022, .https://cityrenewables.org/transaction-tracker/ Accessed May 2022.

Next Steps

For a project to begin providing electricity in 2025, planning and partnership work by the County would need to begin soon. An estimated timeline of activity could include:

2022	Finalize renewable energy procurement partners by the end of year. Understand power procurement integration with Water and Sewer Utilities, School District, BRCPC members, or other larger local entities to see how their goals might align. Work to educate and reach alignment within FACT or to serve as a partner to BRCPC's renewable energy procurement work. Review existing contracts with TESLA and other onsite solar contracts to understand contract options related to procurement strategy.
2023	Work with internal stakeholders to build a renewable energy procurement strategy based on group consensus grow understanding of procurement for offsite PPAs, and supplier led procurement options, either of which will serve as a primary source of renewable electricity. Leverage public processes and tools such as those provided by City Renewables.
2024	Seek a new solicitation for electricity supplier to provide PJM Subaccount services, including information in the RFP about the services needed to integrate and support an offsite PPA. Begin multifaceted procurement process for first renewable electricity PPA with an RFP and a procurement process inclusive of best and final offer for most qualified vendors.
2026	Commercial Operation Date for first offsite power purchase agreement. Begin procurement process for second Renewable Electricity PPA.
2028	Commercial Operation Date for second offsite power purchase agreement.

Metrics to Track Progress

- The portion of electricity that is renewable and which sources are being used.
- The total cost of electricity and average unit costs for electricity.
- The impact that large energy projects might have on the County's electricity needs including, building and transportation electrification, energy efficiency and other policy changes.

Strategy E2: Low-Carbon Gas

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 239 MT CO_2e **2050** 239 MT CO_2e	None	DEE DPW	N/A
Co-Benefits	**Ongoing Costs**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Supports transition to renewable energy & reduce natural gas usage	**$** RNG will likely be a higher cost than conventional gas in 2025	Division of Water & Sewer	N/A

Through this strategy, the County would perform a pilot of renewable natural gas (RNG) use at 585 Himes Ave. RNG is used to displace all conventional natural gas use in the facility. If successful, this demonstration project could be replicated in other County buildings. No changes in infrastructure are required to use RNG in a facility. RNG is a term for biologically-derived gas or biogas, which serves as a direct substitute for fossil fuel derived gas. Since RNG is derived from biological sources (the decomposition of organic matter) that previously absorbed carbon dioxide, it is treated as a zero-carbon fuel. RNG is not widely available in the market, however it is anticipated that more projects and product offerings will become more widespread in the coming years as organizations seek to reduce emissions without large infrastructure changes.

Anticipated GHG Reductions

Through this strategy, an estimated 239 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario.

Relative Costs to Implement

As RNG is still not a widely available resource at this time, cost curves are largely unknown. It is anticipated that by 2025, RNG will be available as either an actual supply or as renewable attribute, however current procurement opportunities are largely limited to large industrial customers. Costs for RNG in 2025 are largely unknown since supply amounts of RNG in the current marketplace are very small. It is likely that RNG will have a premium cost when compared to fossil fuel natural gas in 2025, but it is difficult to project any specific costs or savings given changing energy markets. Costs for RNG should be evaluated and compared to infrastructure and fuel costs for facility electrification as this measure is considered in 2025.

Next Steps

For a project to begin providing renewable natural gas in 2025, the County should prioritize tracking the cost effectiveness of RNG and ensuring that it has a means to contract for RNG in the future. An estimated timeline of activity could include:

2022	Review natural gas procurement and incorporate RNG options in future contract.
2023-2024	Track cost effectiveness of RNG, local sourcing opportunities and long-term contract opportunities.
2025	Purchase RNG for pilot site.
2026	Track RNG pricing to understand opportunities for additional RNG procurement.

Metrics to Track Progress

- The availability of RNG and/or RNG offsets in 2025
- The cost effectiveness of RNG over time as compared to fossil fuel gas

Strategy E3: Green Building Standards

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with CEAP Other Strategies
2030 211 MT CO_2e **2050** 823 MT CO_2e	**$$** $485,000-$638,000	DEE DPW	Buildings will likely require the purchase of 100% renewable electricity to be considered Green Buildings.
Co-Benefits	**Ongoing Savings**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces electricity use and natural gas usage	**$** This measure will save money from energy savings	Division of Water and Sewer, Division Solid Waste,	Institute a building performance standard as it relates to the recently passed Climate Solutions Now Act.

Through this strategy, the County would institute Green Building Standards for new construction and major renovations that will institute standards for energy design. Standards would ensure that all new construction and major renovation are both energy efficient and capable of being carbon neutral once powered by renewable electricity. Exact language and structure of a new green building standard would need to be developed by the County with stakeholders to ensure that the standard met expectations on facility needs and did not impose excessive costs. Green building standards for local governments are not uncommon and a variety of jurisdictions have implemented laws, executive orders, and other programs[14] to ensure that climate progress is achieved through large capital projects. This strategy would align with the recently passed Climate Solutions Now Act and ensure that any investments made in facilities meet the short- and long-term goals and the Building Energy Performance standards outlined by the Act. Most relevant to this strategy is the component of the legislation which requires large buildings to meet net zero energy performance requirements by 2040. New fossil fuel-based infrastructure may not meet compliance with the Building Energy performance Standards and the County should

Maryland's Climate Solutions Now Act

The Maryland recently passed The Climate Solutions Now Act of 2022 which puts in place several building related rules including:

- Commercial and multifamily buildings 35k+ gross square footage to begin benchmarking and reporting data by 2025
- Statewide energy performance standards established through regulations.
- 20% reduction in net direct greenhouse gas emissions on or before January 1, 2030, as compared with 2025 levels for average buildings of similar construction
- Net–zero direct greenhouse gas emissions on or before January 1, 2040
- MDE to adopt regulations on or before June 1, 2023.

[14] Municipal Green Building Law Data Base, Columbia University (2022) https://climate.law.columbia.edu/content/municipal-green-building-law-database

work to ensure that their green building standards are in line to perform with the new law.

Anticipated GHG Reductions

Through this strategy, an estimated 823 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario.

Relative Costs to Implement

Green buildings typically are cost effective investments over their useful life. In addition to energy savings, they typically provide significant non-energy savings including a decrease in operational costs and an increase in asset value. In addition, they ensure productivity, comfort, health, and wellbeing for occupants. New construction of green buildings does cost a premium over conventional construction. Net zero building construction costs an estimated $7.50 per square foot, or a 5% increase compared to conventional construction.[15] Based on the expected growth of facilities, ICF estimates annual construction costs to be between $485K-$638K annually based on the recent studies. These costs may decrease over time as net zero construction becomes more standard.

Next Steps

For new construction and major renovation projects to be both energy efficient and capable of being carbon neutral once powered by renewable electricity, the County will need to begin policy research, engage in stakeholder work and ultimately implement the policy. An estimated timeline of activity could include:

2022	Review best practices from other jurisdictions and track Climate Solutions Now Act for language related to meeting the 2040 standard for buildings.
2023	Review and identify implementation options (legislation, executive action, etc.), Engage internal and external stakeholders on policy options and determine recommendation for action.
2024	Educate key implementors on the changes and ensure new designs meet the standard.
2025	Implement new construction and major renovation standard for all new construction.

Metrics to Track Progress

- New Building certifications and major construction projects
- Energy intensity use of new facilities
- Percent of buildings meeting/using standards?

[15] Net Zero and Living Building Challenge Financial Study: A Cost Comparison Report for Buildings, New Buildings Institute (2014) https://newbuildings.org/resource/net-zero-and-living-building-challenge-financial-study-cost-comparison-report-buildings/

Strategy E4: Energy Management Database and Building Energy Efficiency

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 1,042 MT CO_2e **2050** 1,868 MT CO_2e	**$$$** $10.9 Million investments in energy efficiency over next 15 years	DPW-Energy Efficiency DEE-Energy Management Database	Energy efficiency reduces electricity demand and the amount of renewable energy required for purchase. Align implementation with Climate Solutions Now Act, related to building energy performance standard.
Co-Benefits	**Ongoing Savings**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces electricity use and natural gas use	**$$** Savings of $386,000 annually once implemented	Division of Water & Sewer Division of Solid Waste, Aurora Management-Citizen's Care and Rehab Center (County-owned)	N/A

Through this strategy, the County would implement an energy management database and increase building energy efficiency in County facilities to achieve an 11% reduction in total electricity and natural gas use by 2030 from a 2018 baseline. Additionally, this strategy contributes significantly with the interim goal of 15% by 2027 to align with the MD Smart Energy Communities Program. This strategy would align with the Climate Solutions Now Act, passed in April 2022 by the state of Maryland, which requires large buildings to meet net zero requirements by 2040 and help to ensure that the County's investments are in line to perform with the new law.

Energy Management Database

An energy management database will provide the County with a robust platform for decision making. The current management structure of data does not allow for a deep understanding of building energy use and facility benchmarking without long manual processes. Automation of energy management and facility benchmarking will give Frederick County access to this information on a regular basis and allow the County to receive monthly feedback on energy use and cost. Further, if sub-metering were installed in buildings, it would allow FCG to track data more frequently than monthly.

Key Features of an Energy Management Database

- Facility energy benchmarking (including integration with ENERGY STAR® Portfolio Manager)
- GHG and renewable energy tracking
- Measurement and verification of energy investments
- Utility bill entry, accounting, auditing, and budgeting features
- Robust cost, energy use, and carbon reporting functions
- Calendar and weather normalization of data

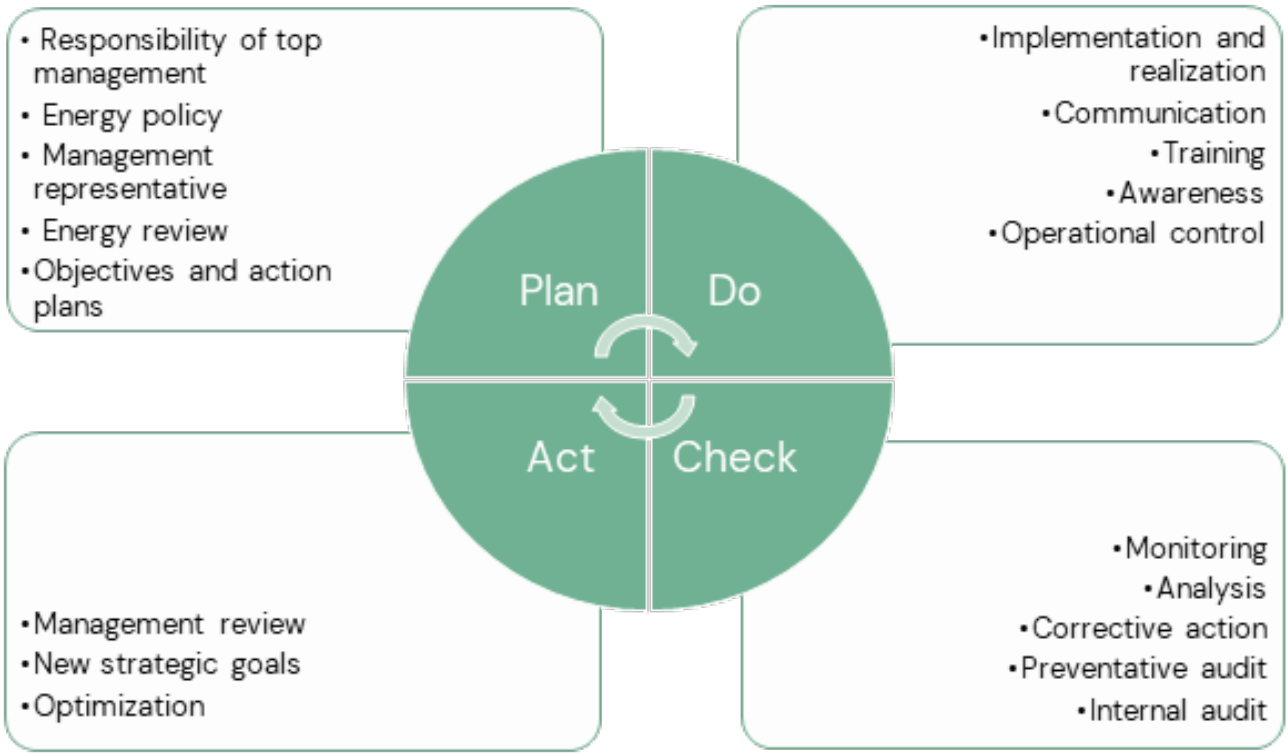
Right now, the County can only access data on a monthly basis, and there is not continuous progress monitoring. An energy management database will allow the County to track energy use and cost across all of its buildings, connecting building attributes such as size and use with energy data. Energy management database software integrates with financial records, supports bill scanning, and audits utility bills for anomalies and errors. These systems allow for custom reporting for energy uses and

cost. The County can use this tool to automate energy benchmarking with ENERGY STAR® Portfolio Manager, allowing the County to understand overall building performance. A system will also help the County as they seek to comply with the Climate Solutions Now Act, recently passed in the state of Maryland, which requires large buildings to meet net zero requirements by 2040. Once the County has foundational energy management tools in place, they can build out a cyclical process for energy management that will enable them to have:

- Continuous access to energy use and costs,
- Continual benchmarking capabilities, and
- The ability to track investments monthly feedback loop on work completed.

With that in place, the County can implement an ISO 50001-type program where they plan, act, track and then set new goals related to their energy efficiency implementation plans (see Figure 15.)

Figure 15: ISO 50001 Energy Management System Process



Building Energy Efficiency

This strategy also includes the implementation of a combination of multiple energy efficiency improvements, including lighting retrofits to install LEDs, upgrading HVAC equipment to high-efficiency models (when equipment nears the end of its useful life), and installing BAS. To maximize reductions that can be achieved through energy efficiency in County facilities, this strategy should follow data tracking actions so that a robust energy management system is in place that allows for continuous and accurate data tracking. Larger facilities eligible for energy efficiency are outlined in Technical Appendix B: Mitigation Analysis Assumptions and Methods, Section 9.1.4.

Anticipated GHG Reductions

Through this strategy, an estimated 1,868 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario.

Relative Costs to Implement

Energy management databases typically have an annual cost through a software as a service contract, or an operations license. There can be a setup fee of tens of thousands of dollars, followed by annual maintenance costs below $100,000 once the systems are set up.

Building energy efficiency can be a very beneficial investment, particularly when pursuing measures demonstrated as effective. The measures selected for implementation (LED lighting retrofits, HVAC equipment upgrades and HVAC controls) have been proven cost-effective and should be prioritized. Given the County has significant experience performing building efficiency projects in-house, ICF recommends the County keep this project labor in-house to maintain low-cost implementation. ICF has carefully examined the County's energy management data and associated information to target the facilities that will produce significant energy savings. ICF derived an average cost-per-square foot from recent County efficiency projects—$1.79/sq. ft. for lighting retrofits and $7.99/sq. ft. for HVAC equipment (see Table 9), and a value of $3/sq. ft for building controls installations—and applied those to estimate anticipated costs for associated measures. Actual costs and savings from efficiency measures may vary significantly depending on building conditions and equipment types. When implementing these measures, the County can prioritize those which are most cost effective today and those which are replacing equipment that has reached the end of its useful life. Using this implementation concept will maximize payback to the County, while providing infrastructure improvements to facilities.

Table 9: Implementation Costs for LED Lighting and HVAC Equipment

	LED Lighting	HVAC Retrofits	HVAC Controls
15-year Implementation Costs	$1,489,000	$6,248,000	$3,257,000
Annual Cost Savings	$169,00	$19,000	$198,000

Next Steps

Energy Management Database

2022

Execute contract with Enel-X for energy data management services since they are already under contract with the Division of Water and Sewer Utilities. Connect new utility bill system to ENERGY STAR® Portfolio Manager (ESPM) to gain efficiencies. Start of a 24-month pilot with existing platform for bill scanning. Work with facility managers and County energy managers to categorize facilities by use type, operating hours, and energy intensity to help inform energy efficiency investments.

2023

Benchmark all County buildings above a certain size (e.g., 10,000-20,000 square feet) and consider public disclosure of scores for transparency and as a first step toward a Building Performance Standard and to better understand needs for compliance with the Climate Solutions Now Act.

Use improved data systems and tracking to set energy targets as part of an updated Comprehensive Energy Plan.

2025	Evaluate software options and integrate electrical submeter information through HVAC BAS building systems to enable tracking of onsite solar photovoltaic (PV) projects, electric vehicle charging equipment, and to identify energy conservation and cost savings opportunities in large buildings. Determine a tracking system for investments and facility upgrades and define a tracking process in alignment with ISO 50001.

Building Energy Efficiency

2022-2023	Continued implementation of energy efficiency measures and the Frederick County Government Comprehensive Energy Plan from April 2021 as informed by the Energy Management Database.
2023-2030	Update the Comprehensive Energy Plan and execute energy efficiency investments in alignment with opportunities found through the energy management database and in alignment with compliance with the Climate Solutions Now Act.

Metrics to Track Progress

- Energy use in facilities
- ENERGY STAR Portfolio Manager Scores and EUI

Strategy E5: Building Electrification

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 610 MT CO_2e **2050** 1,084 MT CO_2e	**$$$** $4.1 Million in investments over next 15 years	DPW DEE	Building electrification increases annual electricity amount to purchase with 100% renewable energy.
Co-Benefits	**Ongoing Costs**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces natural gas use	**$$** Additional operating costs of electrification estimated at $24,000 annually	Division of Water and Sewer Utilities Division of Solid Waste	N/A

Through this strategy, the County would pursue electrification of all end-uses within targeted buildings. This primarily targets space heating, though would extend to water heating, cooking, and any other onsite combustion as well. This strategy currently targets buildings over 10,000 sq. ft. Fuel use (natural gas, fuel oil, or propane) would be eliminated in impacted buildings, and electricity use would increase with a conservative, average efficiency gain of 18%. Deeper emission reductions are then achieved through renewable electricity procurement. This strategy would align with the recently passed Climate Solutions Now Act, recently passed in the state of Maryland, which requires large buildings to meet net zero requirements by 2040 and help to ensure that the County's investments are in line to perform with the new law. In implementing this strategy, the County

will need to review specific buildings and seek to understand the ease of electrification constructability, including how economically or technical feasible the building might be to transition to a heat pump, or variable refrigeration flow systems that use electricity.

Anticipated GHG Reductions

Through this strategy, an estimated 1,084 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario, assuming all additional electricity is 100% renewable.

Relative Costs to Implement

Building electrification usually requires higher upfront costs compared with simple replacement of existing combustion systems. For instance, other work such as electric panel upgrades may be required to facilitate the fuel switch. However, lifecycle costs are generally cheaper than conventional systems. Cost effective electrification investments should be prioritized and planned for as primary HVAC equipment approaches the end of its useful life. Facilities with significant hydronic heating (those which use boilers, radiators, or significant hot water for primary heating) may have higher costs for electrification. Similar to building efficiency, ICF recommends County implementation of electrification measures to help maintain low-cost implementation. ICF has carefully examined the County's energy management data and associated information to target the facilities that will produce significant energy savings. We derived an average cost-per-square foot from recent County HVAC projects of $7.99/sq. ft. and applied that to estimate anticipated costs for associated measures, resulting in an estimate $4.1 million investment over the next 15 years. Actual costs may vary significantly depending on building condition and equipment types.

Next Steps

2022-2025	Continued implementation of electrification measures and the Frederick County Government Comprehensive Energy Plan from April 2021 as informed by the Energy Management Database. Review of specific buildings for constructability concerns and planning of electrification.
2023-2030	Update the Comprehensive Energy Plan and execute electrification investments in alignment with opportunities found through the energy management database and in alignment with compliance with the Climate Solutions Now Act.

Metrics to Track Progress

- Energy use in facilities
- ENERGY STAR Portfolio Manager Scores and EUI

3.3.2 Transportation

GHG mitigation strategies under the Transportation sector aim to reduce the GHG emissions related to County fleet management and employee commuting. There are three key strategies for fleet management, layered by priority. The first strategy, electrify the Country fleet, directly reduces GHG emissions from gasoline- and diesel-powered vehicles by transitioning to electric vehicles. The strategy assumes that all additional electricity demand from fleet electrification is purchased with 100% renewable energy, and detailed information is available in the separate EV study. Passenger cars and light-duty trucks not eligible for EV replacement fall under the second strategy, adopting a hybrid replacement program. The third layered strategy for fleet management is converting the remaining diesel fleet to biodiesel. Transitioning the remaining on-road general and transit to biodiesel will reduce GHG emissions from conventional diesel.

GHG mitigation strategies under the transportation sector also address employee commuting and driving behavior and education. The fourth strategy, expand telecommuting opportunities, reduces transportation emissions from employee commuting activities. Finally, there are additional strategies focused on education and engagement that may be key components for emission reduction success. These are not modeled in this CEAP, but they include:

- Improve access to alternative modes of transportation for employees,
- Provide and empower active mobility, and
- Educate employees on benefits of economical vehicles.

The **four strategies** in this sector will reduce overall GHG emissions annually by 5,146 CO_2e by 2030 and 9,346 MT CO_2e by 2050. Table 6 shows emission reductions from each strategy.

The largest contributing mitigation strategy for transportation is the electrification of the County fleet, followed by adopting a telecommuting strategy and then purchasing hybrid vehicles for fleet vehicles that are not recommended for electrification.

Sector Overview

Description of climate actions

The four strategies modeled for mitigating transportation emissions are:

Mitigation Strategy	Strategy Description
Strategy T6: Electric Vehicle (EV) Adoption	Transitions all eligible gasoline- and diesel-powered vehicles to electric vehicles.
Strategy T7: Hybrid Replacement Program	Replaces all non-EV eligible vehicles with hybrid vehicles.
Strategy T8: Diesel to Biodiesel Conversion	Utilizes 20% biodiesel (B20) in diesel vehicles.
Strategy T9: Telecommuting	Expand opportunities for telecommuting for County employees.

Key assumptions for the mitigation strategies can be found in Technical Appendix B: Mitigation Analysis Assumptions and Methods: 9.2 Transportation Strategies.

Strategy T6: Electric Vehicle Adoption

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 1,631 MT CO_2e **2050** 6,860 MT CO_2e	**$$**	Fleet Services Department Head will need to lead the integration of EVs and AFVs into the fleet	Fleet electrification increases annual electricity amount to purchase with 100% renewable energy. Electrified vehicles are not eligible for other transportation strategies.
Co-Benefits	**Ongoing Savings**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Supports transition to cleaner mobile fuels	**$$$** $23 million in savings	Department of Fleet Services (including drivers, maintenance and repair staff, and operations), Procurement and Contracting, Department of Public Works, Department of Facility Maintenance, County Planning and Permitting, Sheriff's Office, Risk Management, Human Resources (for staff training), Health Department, Economic Development, and Potomac Edison	Transition all bus fleets to electric and enhance ridership experience; transition light and medium duty vehicles to all electric.

Through this strategy, the County would begin to electrify on-road fleet vehicles beginning in 2024. This strategy will replace gasoline- and diesel-powered vehicles in the County's fleet with electric vehicles (EVs), where cost effective. Fleet electrification recommendations and greenhouse gas emissions reductions will be updated through further discussions with the County and by incorporating updated fleet data into the analysis.

Anticipated GHG Reductions

Through this strategy, an estimated 6,860 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario, assuming 100% renewable electricity purchasing. Without 100% renewable electricity, an estimated 4959 MT CO_2e will be reduced annually by 2050.

Relative Costs to Implement

Purchasing EVs presents a large, upfront investment due to a higher purchase price compared to equivalent internal combustion engine (ICE) vehicles. While EVs often have a higher purchase price than ICE vehicles, they offer lower fuel and maintenance and repair costs throughout their lifespans, resulting in lower total cost of ownership (TCO) than ICE vehicles. For this analysis, throughout the total cost TCO timeframe, 2024 to 2050, the County will save approximately $23 million dollars by adopting the EV replacement recommendations. By 2030 the TCO of the electrification recommendations will breakeven with business as usual replacements, creating annual savings for the fleet.

Next Steps

The County will provide updated fleet data for further analysis. This updated information may adjust recommendations, emissions savings, and cost savings. Integrating EVs into the fleet will require the installation of EV charging stations across County properties. The County will need to work with Potomac Edison to confirm

new electricity load requirements can be met and secure any electrical capacity upgrades needed at EV charging sites.

Metrics to Track Progress

- Number of EVs acquired by the fleet to replace internal combustion engine (ICE) vehicles.

Strategy T7: Hybrid Replacement Program

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other Strategies
2030 71,423 MT CO_2e **2050** 16 MT CO_2e	**$** +$2,000 per vehicle	Fleet Services Department	The current fleet assessment recommends all sedans, SUVs, minivans, and all but one light-duty pickup truck for electrification. These vehicles are not eligible for hybrid replacement.
Co-Benefits	**Ongoing Savings**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Supports transition to cleaner mobile fuels	**$$** 45% fuel cost savings	Same as in Strategy T6	N/A

Through this strategy, the County would purchase hybrid electric vehicles (HEVs) as gasoline vehicles in the Country fleet are retired, when EVs are not purchased. This strategy will reduce the amount of gasoline consumed by the fleet. This strategy excludes vehicles that have already transitioned to EVs and only applies to passenger cars and light-duty trucks. It is assumed all remaining vehicles will be converted into hybrids by 2035.

Anticipated GHG Reductions

Through this strategy, hybrid savings will peak in 2032 with an estimated 1,423 MT CO_2e reduced annually, then savings will begin to lower as electric vehicle replacements dominate the fleet.

Relative Costs to Implement

Adopting HEVs into the County fleet may result in increased purchase prices for new vehicles. On average, HEVs cost approximately $2,000 more per vehicle than internal combustion engine equivalents.[16] The current fleet assessment recommends all sedans, SUVs, minivans, and all but one light-duty pickup truck for electrification.

Next Steps

To implement this strategy, the County should start by identifying which vehicles are recommended for hybrid replacement. These will primarily be vehicles that are not recommended for electrification. The County should also review which vehicles in the fleet require replacement in the next few years and prioritize transitioning those to hybrids first.

Metrics to Track Progress

- Number of gasoline vehicles replaced by HEVs
- % of vehicles

[16] Argonne National Laboratory. 2021. "AFLEET Tool 2020." Retrieved from: https://greet.es.anl.gov/index.php?content=afleet

Strategy T8: Diesel to Biodiesel Conversion

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 1,423 MT CO_2e **2050** 58 MT CO_2e	No cost	Fleet Services Department	Only relevant to vehicles not included in electric vehicle adoption strategy.
Co-Benefits	**Ongoing Savings**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Supports transition to cleaner mobile fuels	**$** $1.25 per gallon	Fleet Services, Highway Operations, TransIT Services, Frederick County Public Schools, Water and Sewer Utilities, Fire and Rescue Services, Solid Waste and Recycling	Facilitate the availability of renewable fuels for all vehicle types and home heating.

Through this strategy, the County would utilize 20% biodiesel (B20) in diesel vehicles., excluding vehicles that have been recommended for electrification. Savings here will be minimal, depending on the electrification level chosen by the County. The current fleet assessment estimates that 105 diesel vehicles will not be cost effective to electrify, making them eligible for biodiesel adoption.

Anticipated GHG Reductions

Through this strategy, an estimated 165 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario.

Relative Costs to Implement

Integrating B20 into the fleet should result in immediate cost savings; no vehicle conversions are required and B20 costs less per gallon than diesel, according to the County's fuel contract. The County currently pays $4.27 per gallon for diesel, and the average Central Atlantic price for B20 is $3.02 per gallon.[17] The County can expect to save approximately $1.25 per gallon by adopting B20 for all non-electrified diesel vehicles.

Next Steps

The County needs to research the availability of B20 and review any changes that need to be made to any fuel purchasing agreements.

Biodiesel blends up to B20 have few compatibility issues with diesel infrastructure. If the County considers filling any diesel storage tanks with biodiesel, the County should consider the following recommendations beforehand:

- The County should crosscheck existing tank compatibility with the Department of Energy's *Biodiesel Handling and Use Guide* to determine whether existing infrastructure is compatible with holding and dispensing B20.[18] Tanks that are confirmed as compatible should be prioritized for B20.

[17] U.S. Department of Energy. January 2022. "Clean Cities Alternative Fuel Price Report." Retrieved from: https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_january_2022.pdf

[18] Department of Energy. Biodiesel Handling and Use Guide (Fifth Edition) https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf

- For unconfirmed tanks, before storing biodiesel the County should take every effort to confirm compatibility. If the County cannot confirm any additional storage tanks are compatible with biodiesel, the County should only rely on the tanks that are confirmed as compatible.

> **Metrics to Track Progress**
>
> - Number of diesel gallons displaced by B20

Strategy T9: Telecommuting

Annual GHG Emission Reductions from BAU	Upfront Costs	Lead	Overlap with Other CEAP Strategies
2030 2,042 MT CO_2e **2050** 2,412 MT CO_2e	**$** Costs for developing telecommuting policy	DEE Human Resources	Increased telecommuting may have an impact on building energy use as less employees are occupying County offices.
Co-Benefits	**Ongoing Costs**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces mobile fuel use	N/A	County employees, Commuter Connections, Telework Resource Center	Support and promote telework.

Through this strategy, the County would expand opportunities for telecommuting for County employees. As a result of shifts in workforce commuting patterns from the COVID-19 pandemic, the County is already considering some procedures and processes to improve telecommuting opportunities. This strategy can reduce GHG emissions by reducing the daily need for employees to commute to work, typically by private passenger vehicles.

Anticipated GHG Reductions

Through this strategy, an estimated 2,412 MT CO_2e will be reduced annually by 2050 compared with the BAU scenario.

Relative Costs to Implement

The cost to implement this strategy is low. Telecommuting requires few costs by the County.

Next Steps

To move forward with a telecommuting strategy, the County will need to develop a telecommuting policy and work with employees to create teleworking agreements. Additionally, the County will need to review and address employee eligibility and availability, hardships, technology needs, and other considerations related to telecommuting.

> **Metrics to Track Progress**
>
> - Percent of employees telecommuting
> - Reduction of annual miles commuted

3.3.3 Waste

The **three strategies** in this sector will reduce GHG emissions, but emission reductions modeling is not included in this CEAP due to scope (i.e., the emissions that would be impacted—waste generated within but disposed of outside of the County's boundaries are not included in the baseline GHG inventory).

Sector Overview

Description of climate actions

The three strategies modeled for mitigating waste emissions are:

Mitigation Strategy	Strategy Description
Strategy W10: Increase County waste diversion	Increases commercial food waste composting for residents and businesses, reduce and recover food waste from County facilities, and standardize bins and signage at County facilities to increase waste diversion.
Strategy W11: Reduce County employee waste generation	Reduces the amount of waste generated by County employees.
Strategy W12: Sustainable purchasing and procurement	Involves drafting and adopting a sustainable procurement policy for County purchases.

Key assumptions for the mitigation strategies can be found in Technical Appendix B: Mitigation Analysis Assumptions and Methods: 9.3 Waste Strategies.

Strategy W10: Increase County Waste Diversion

Annual GHG Emission Reductions	Upfront Costs	Lead	Overlap with Other CEAP Strategies
 Addresses high emissions waste product (food), within broad communitywide scope.	$$ $175,000	Solid Waste & Recycling	N/A
Co-Benefits	**Ongoing Costs**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces waste generation	$$ $40,000	Procurement, DPW, Custodial Services	

Through this strategy, the County will increase commercial food waste composting for residents and businesses, reduce and recover food waste from County facilities, and standardize bins and signage at County facilities to increase waste diversion.

Anticipated GHG Reductions

Reducing the amount of community food waste to the County-operated landfill will result in considerable reductions GHG emissions due to the communitywide scale of impact. Because food waste is typically the largest contributor of waste related GHG emissions, reducing and recovering food waste at County facilities and events would also contribute notable GHG emission reductions.

While the overall GHG savings potential from standardizing bins at County facilities is relatively smaller, taking steps to increase waste diversion at County facilities presents an important opportunity to lead by example and pilot waste diversion strategies for educational and informational purposes.

Relative Costs to Implement

Expansion of communitywide composting programs will require upfront planning and launch costs, as well as ongoing program management costs. Costs associated with edible food recovery at County facilities would consist primarily of staff time. Improving and standardizing bins and signage at County facilities would include material costs for new bins and signage as well as staff time to train and educate County staff.

Next Steps

Implementation of this strategy consists of the following action steps:

- **Expand food composting.** Expand commercial food waste composting opportunities for County residents/businesses, such as through implementing a pilot program or expanding current composting offerings or partnering with regional composting facilities.
- **Recover edible food.** Limit food waste when food is served as part of County operations. Identify food rescue organization partners and establish a protocol for this food rescue.
- **Standardize waste bins and signage in County facilities.** When appropriate, update County contract with Division of Public Works (DPW) to provide sets of three bins (recycling, garbage, and compost) next to each other, with consistent color-coding and clear signage, in County facilities to improve recycling and composting rates. Complement with training on correct sorting.

> **Metrics to Track Progress**
>
> - # of County events with food recovery
> - Pounds of food recovered
> - County waste diversion rate (%)
> - County waste generation (tons)

Strategy W11: Reduce County Employee Waste Generation

Annual GHG Emission Reductions	Upfront Costs	Lead	Overlap with Other CEAP Strategies
 Medium Potential: Addresses upstream GHG emissions from goods and services, but within limited County scope.	$$ $100,000	Procurement	N/A
Co-Benefits	**Ongoing Costs**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces waste generation	$$ $40,000	Community event/venue staff, Office of Project Management, DPV, and Facilities Management	Prevent disposal of organic material.

This strategy aims to reduce the amount of waste generated by County employees. Actions in this strategy focus on reuse and repair programs, edible food recovery, and diversion of common and high-impact waste items such as construction and demolition (C&D) waste, paper, and single-use foodware.

Anticipated GHG Reductions

Actions within this strategy address both traditional "downstream" GHG emissions, such as methane from organic waste, as well as "upstream" GHG emissions, such those released through manufacture and transport of construction materials. While these actions would address important GHG emissions sources, including food waste, construction materials, and paper products, the limited scope of this strategy to County employees and facilities limits the relative GHG emissions and waste reduction impacts.

Relative Costs to Implement

Costs of this strategy consist largely of County staff time to coordinate, expand, and maintain programs and processes. Other costs include consulting support and purchasing of equipment (e.g., scanners to facilitate transition to digital documentation).

Next Steps

- **Participate in regional reuse programs for County items.** Expand regional reuse programs for County surplus items. Identify partners that will purchase or receive (as donation) or identify an online marketplace for salvaged materials, furniture, and equipment from renovated buildings or whenever there is furniture turnover (new office chair, etc.). Investigate opportunities to increase efficiency of handling hard-to-process items (e.g., cubicle walls).
- **Set up or expand repair programs for County items.** Set up or expand repair programs for County assets such as furniture or computer equipment and expand and ensure use of recycling programs in place for these items, including take-back programs.
- **Reduce waste from events where food is served.** Explore a requirement for all County-funded community events where food is served to reduce waste. Begin with a waste reduction plan for one or more County events, such as the County picnic. Provide guidance information materials to assist those who manage events.
- **Develop C&D waste plans for all County construction.** Foster coordination between Office of Project Management and DPW to identify strategies for preventing/diverting C&D waste, including potentially developing and monitoring C&D waste plans for all County construction projects.
- **Reduce paper waste.** Switch to digital for all internal and external paper uses when feasible. In cases where digital paper use is not possible, require double-sided printing.
    - Internal: HR paperwork, meetings, presentations, reports, invoices, etc.
    - External: Invoices, payments, contracts, digital signatures, etc.
- **Limit single-use waste at County properties.** Reduce use of non-reusable food waste by requiring, incentivizing, supporting and/or promoting reusables for on and off-site dining (to-go or delivery) at County properties.

> **Metrics to Track Progress**
>
> - County employee waste generation (tons)
> - # of waste plans established for County events

Strategy W12: Sustainable Purchasing and Procurement

Annual GHG Emission Reductions	Upfront Costs	Lead	Overlap with Other CEAP Strategies
Medium Potential: Addresses upstream GHG emissions from new products, but within limited County scope	$ $10,000	Procurement	N/A
Co-Benefits	**Ongoing Costs**	**Stakeholders and Partners**	**Relevant CEMWG Strategy**
Reduces waste generation	$ $1,000	County departments and County vendors	Adopt sustainable purchasing policies to favor the selection of sustainable, low-carbon products and services.

This strategy involves drafting and adopting a sustainable procurement policy for County purchases.

Anticipated GHG Reductions

Sustainable purchasing can reduce GHG emissions in a variety of ways, including through reduced product packaging materials, reduced product travel-related emissions, and reduced "upstream" GHG emissions associated with the manufacture of goods such as office furniture and food. While the GHG savings from this strategy are limited to County purchases, the potential to include County vendor requirements could expand the scope of this strategy to amplify its impact.

Relative Costs to Implement

Upfront costs consist largely of staff time to develop the policy. We estimate limited ongoing staff costs for monitoring and reporting.

Next Steps

The development of a County sustainable purchasing policy could include the following action steps:

- **Convene a cross-departmental team.** A cross-departmental team is valuable to vet policy components and achieve buy-in.
- **Draft the procurement policy.** The team can define sustainable procurement, determine what categories and criteria will be included in the policy, decide what requirements are feasible, and develop roles and responsibilities and systems for accountability and reporting.
- **Conduct ongoing data collection and reporting.** Regular reporting will help the County understand how successful the policy is in meeting goals and objectives and any adjustments needed to overcome barriers or improve the policy.

> **Metrics to Track Progress**
>
> - % or $ of purchases meeting procurement policy standards

4 Climate Risk and Vulnerability Assessment

4.1 Introduction

In addition to efforts to reduce greenhouse gas emissions, Frederick County's climate initiatives aim to recognize and prepare for the impacts of climate change.

The purpose of this climate risk and vulnerability assessment (CRVA) is to systematically identify potential risks to County division assets and operations under a changing climate. The CRVA is intended to inform County decision makers—ranging from the administration on strategic planning for the future; to division heads who are developing projects; to operations and maintenance staff who may already be working on adaptive measures—on forward-looking resilience actions to prepare for future climate conditions. Additionally, the CRVA discloses material risks to investors as well as citizens that the County serves.

This risk and vulnerability assessment first presents the main climate hazards that will affect the County due to climate change—flooding, extreme heat, winter storms, and drought— and then discusses how these hazards might create risks for County division assets and operations and which of these risks will have the highest consequences.[19]

Key Findings

This CRVA identified priority risks, which helped inform the resilience solutions discussed in the following chapter. **The study team found that high-priority risks across sectors include:**

- **Flooding leading** to **interruptions** in Division operations or use of assets; **damage** to infrastructure, and water or environmental **contamination** and resulting **human health impacts**.
- **Extreme heat** leading to **human health impacts** and **stress to County infrastructure.**

This chapter presents the following information:

- **Methodology**: Summarizes the steps taken by ICF and the County to identify priority climate hazards and develop an understanding of future conditions; to identify how the priority climate hazards may affect County divisions; and the process for identifying high-consequence risks.
- **The Climate is Changing**: Describes future climate conditions in Frederick County based on data from the National Oceanic and Atmospheric Administration (NOAA) and other sources.
- **Social Vulnerability**
- Reviews socio-economic and demographic characteristics that increase climate vulnerability for certain populations in Frederick County and would have equity implications for division services and operations under changing climate conditions.
- **Climate Impacts and Consequences: High-Consequence Risks**: Discusses how future climate hazards could affect the divisions' assets and operations, focusing on high-consequence (or high-priority) risks.
- **Climate Impacts and Consequences: Other Risks**: Discusses other ways that future climate hazards that have lower projected consequences could affect the divisions' assets and operations

[19] The risk and vulnerability assessment does not focus on non-climate hazards or those with a tenuous correlation to climate change, such as tornadoes. The County Hazard Mitigation and Climate Adaptation Plan provides more details on a wide array of climate and non-climate hazards.

Key Terms

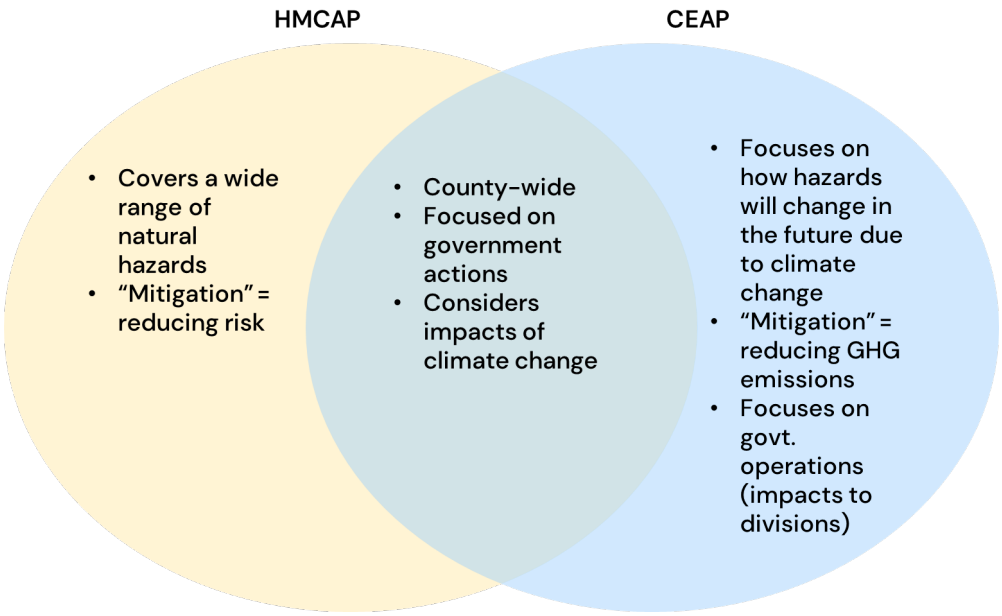
The following terms are useful for interpreting the findings of this climate risk and vulnerability assessment:

- **Adaptation**: An action or strategy to reduce harm from climate change.
- **Resilience:** A state of being able to withstand, absorb, and bounce back from disruptions due to risks.
- **Climate change hazard:** A climate-related variable such as extreme heat, flooding, drought, or winter storms that could create a risk.
- **Climate change risk:** The way in which a climate hazard affects assets or operations (such as increased need for air conditioning due to extreme heat).
- **Consequence:** Results of being impacted by a climate hazard, including severe injury/death, halting normal operations, requiring replacement of an asset, and/or significantly adding costs (e.g., beyond a division's expected budget).

4.1.1 Alignment with 2021-2022 Hazard Mitigation and Climate Adaptation Plan Update

Figure 16 shows that the information in this CRVA is aligned with the County's 2022 Hazard Mitigation and Climate Adaptation Plan (HMCAP). Both the HMCAP and this Climate and Energy Action Plan consider how climate change may result in risk to the County and identify potential strategies for reducing that risk. However, the HMCAP also covers a wide range of natural hazards, whereas this CRVA focuses solely on natural hazards related to climate change, including risks due to future changes that are not addressed in the HMCAP. The CRVA focuses on impacts to Frederick County Government (FCG) assets and operations, whereas the HMCAP takes a broader view to identify hazards to the County as a whole. In the context of this CRVA, "mitigation" refers to the reduction of greenhouse gas emissions, whereas for the HMCAP, "mitigation" refers to reducing risk.

Figure 16: Similarities and differences between the Hazard Mitigation and Climate Adaptation Plan and the Climate and Energy Action Plan



4.2 Methodology

Climate data: ICF used the best available science to estimate future climate conditions in Frederick County. The climate projections for precipitation and heat come from the National Oceanic and Atmospheric Administration (NOAA). NOAA does not have similar projections for winter storms and drought, thus data for estimating future conditions for those hazards come from the National Integrated Drought Information System (NIDIS), the Maryland State Climate Summary, and scientific literature.

The description of future climate conditions focuses on the year 2050 to align with County government planning timelines for the Livable Frederick Comprehensive Plan as well as the lifespan of many projects in the Capital Improvement Program. However, the study team also included longer-term horizons to create a picture of what the future may hold.

Climate impacts and consequences: For this risk and vulnerability assessment, ICF focused on identifying ways that the climate hazards might affect the operations and assets of County divisions. The study team pulled information from literature reviews (including the Metropolitan Washington Council of Governments Climate Risk and Vulnerability Assessment and the Frederick County Hazard Mitigation and Climate Adaptation Plan), expert knowledge, and stakeholder input (i.e., an interactive workshop with division staff).

Prioritization process for identifying high-priority risks: To prioritize risks, ICF worked with County division staff to narrow down the list of full risks by identifying which risks were considered "high consequence." ICF defined "high consequence" as risks that would result in severe injury or death, halt normal operations, require replacement of an asset, and/or significantly add costs (e.g., beyond a division's expected budget). This definition is in alignment with the County Hazard Mitigation and Climate Adaptation Plan and Metropolitan Washington Council of Governments Climate Risk and Vulnerability Assessment.

4.3 The Climate is Changing

4.3.1 Overview

The climate in Maryland and across the world is changing, with more frequent and severe natural disasters and an overall increase in temperatures. These changes are primarily due to an increase in the concentration of carbon dioxide and other greenhouse gases in the atmosphere, which trap solar energy and increase global temperatures.[20] The level of change depends on the amount of current and future greenhouse gas emissions, with more emissions leading to greater changes. This section provides an overview of expected future changes in climate and how they will affect weather patterns and temperature in Frederick County, focusing on extreme heat, precipitation, and subsequent impacts including heating and cooling degree days and flooding.

In addition to gradual increases in temperature, climate change may increase the frequency and severity of severe weather-related hazards in Frederick County. The 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan (HMCAP) identifies extreme heat events and flooding and winter storms as high-priority severe weather events that could be exacerbated by climate change.[21] In addition to short-term extreme weather events, the CRVA also analyzes longer-term climate trends that may affect Frederick County, including drought.

Climate change will not affect everyone in Frederick County in the same way. Extreme weather events have the largest impact on those who are least prepared for disasters. Minority, disabled, elderly, youth, and low-income populations in the County are more susceptible to heat-related stress and illness and less likely to be able to recover if their property is damaged or destroyed in a flood or other extreme event. Reducing global

[20] U.S. Global Change Research Program. 2018. "Fourth National Climate Change Assessment: Chapter 2: Our Changing Climate". Available at https://nca2018.globalchange.gov/chapter/2/

[21] Hazard Mitigation Planning Committee (HMPC). 2017. Frederick County Hazard Mitigation Plan (CHMP).

greenhouse gas emissions globally can affect the degree to which the County will experience changes in the number of extreme heat days, the intensity of precipitation events, or other changes in climate that disproportionately affect vulnerable populations.

The findings in this section focus on presenting climate conditions in the recent past (1994-2013) compared to projected future conditions. Future projections focus on the timeframe of 2050 to align with FCG planning time horizons, but projections for the near-term (2030) and late century (2090) are also provided to develop a fuller picture of predictions of the future.

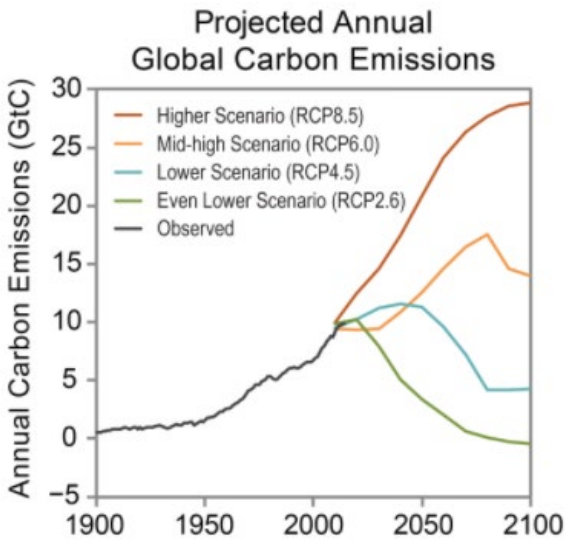
4.3.2 Key Takeaways

- The number of extreme heat days—where temperatures hit 95°F or above—are expected to increase from a historically observed **2-3 days per year** to a future estimated **19-26 days per year by 2050 and 27-62 days by 2090.** Higher temperatures will impact the County in many ways, including but not limited to greater energy needs for cooling and threats to human health.
- The amount of **precipitation is not predicted to greatly change**, but rain events will be less frequent and more intense—which can lead to greater flooding than what the County currently experiences.
- The **risk of droughts as well as winter storms is projected to increase** in the future due to climate change.
- The amount to which humans reduce greenhouse gas emissions globally influences the degree to which climate change will impact Frederick County.

4.3.3 Climate Scenarios

Climate projections come from groups of models that simulate the future climate based on various possible emissions scenarios. This report provides projections from 2020 to 2100 based on a low emissions scenario and a high emissions scenario. The low emissions scenario is based on a future in which humans stop increasing global emissions of heat-trapping greenhouse gases by 2040 and then dramatically reduce them through 2100, referred to as Representative Concentration Pathway (RCP) 4.5. The high emissions scenario is based on a future without reduced emissions in which global emissions of greenhouse gases continue increasing through 2100, also known as RCP 8.5. Figure 17 (developed by the U.S. Global Change Research Program)[22] shows the difference in the amount of carbon dioxide emitted in four RCP scenarios over time.

Figure 17: Carbon emissions through the 21st century (2000-2100) for four greenhouse gas emission scenarios, or Representative Concentration Pathways, developed by the Intergovernmental Panel on Climate Change.



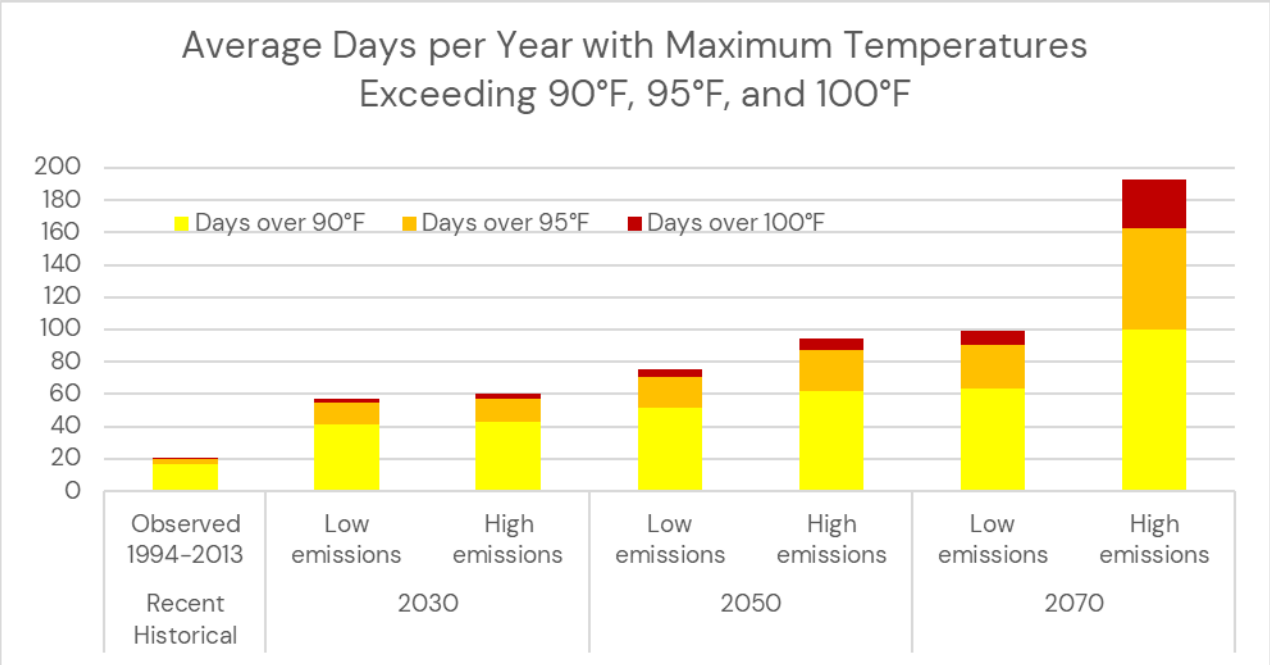
[22] U.S. Global Change Research Program. 2017. "Climate Science Special Report: Fourth National Climate Assessment, Volume I". Available at https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf

4.3.4 Extreme Heat

Frederick County is predicted to experience **more days with extreme heat** under all emission scenarios. Climate projections indicate the County will see a large increase in the number of days per year where the maximum temperature tops 90°F even if actions are taken to curb greenhouse gas emissions.[23] **In recent years (1994-2013), the County has experienced about 17 days per year with maximum temperatures above 90°F and 3 days per year with maximum temperatures above 95°F.** In **2021**, Frederick County experienced **46 days with maximum temperatures above 90°F and 11 days above 95°F** and in **2022**, the County experienced **44 days with maximum temperatures above 90°F and 8 above 95°F**.[24] In other words, the **frequency of extreme heat days roughly tripled in just under 30 years.**

By 2050, the number of days each year where the maximum temperature is over 90°F, 95°F, and 100°F is expected to increase significantly (Figure 18). There is a greater increase in the number of extreme heat days under the high-emissions scenario, with the difference between the two scenarios widening over time. **Models show that by 2050, the region will experience an average of 52 to 62 days over 90°F and 19 to 26 days over 95°F, depending on the carbon emissions scenario** (the low emissions scenario results in the lower end of this range; the high emissions scenario in the higher)**.** By the end of the century, the region is projected to experience 63 to 100 days per year over 90°F and 27 to 62 days over 95°F, depending on the scenario.

Figure 18: Average days where maximum temperatures exceed 90°F, 95°F, and 100°F historically and in the future in Frederick County, MD. Source: NOAA Climate Explorer.



Average annual temperature in Frederick County is increasing. Daily maximum and daily minimum temperatures have increased steadily over the past 70 years and will continue to increase. From 1950 to 2010, the average daily maximum temperature increased by 0.03°F per decade. This warming trend is projected to

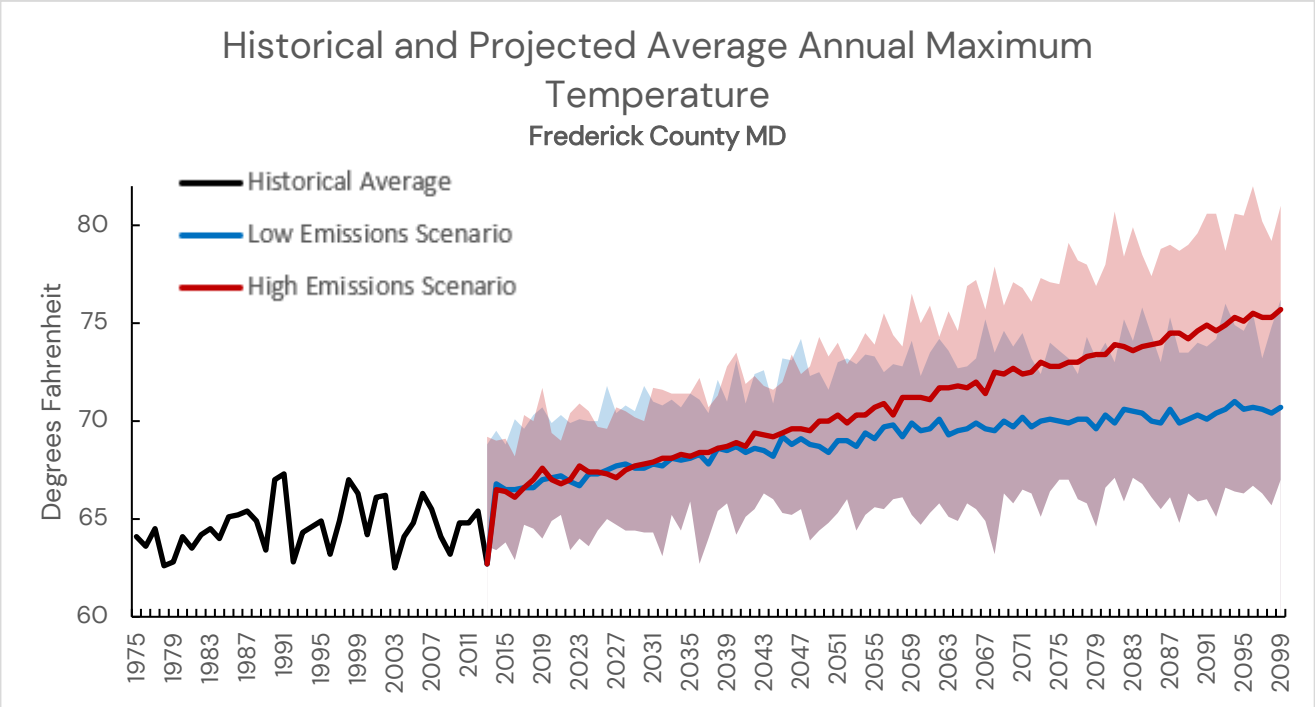
[23] U.S. Federal Government. 2021. U.S. Climate Resilience Toolkit Climate Explorer. https://crt-climate-explorer.nemac.org/. Accessed January 2022.

[24] AccuWeather. "Frederick Maryland." Accessed November 17, 2022 from https://www.accuweather.com/en/us/frederick/21701/october-weather/329303?year=2021.

increase into the future. Compared to the 1994-2013 average daily maximum temperature of 64.8°F, by **2050 the County is projected to see a total increase in annual average maximum temperatures of 4.2°F under a low emissions scenario and 5.2°F under a high emissions scenario.** By 2090, the temperature gap between the two scenarios widens, with temperatures projected to increase by 5.6°F under a low emissions scenario and 9.8°F under a high emissions scenario (Figure 19).

Average daily minimum temperatures also show a warming trend, increasing by 0.36°F per decade from 1950 to 2010. **By 2050, average daily minimum temperatures are projected to increase by 3.1°F under a low emissions scenario and by 4.1°F under a high emissions scenario compared to a historic average daily minimum temperature of 44.5°F**. By 2090, average daily minimum temperatures are projected to increase 4.5°F under a low emissions scenario and by 8.7°F under a high emissions scenario.

Figure 19: Historical and projected average annual maximum temperature for Frederick County (°F). Red and blue fill indicates the range of future projected values under high and low emissions scenarios, respectively. Red and blue lines show the weighted means of projections for high and low emissions scenarios, respectively. Source: NOAA Climate Explorer.



4.3.5 Heating Degree and Cooling Degree Days

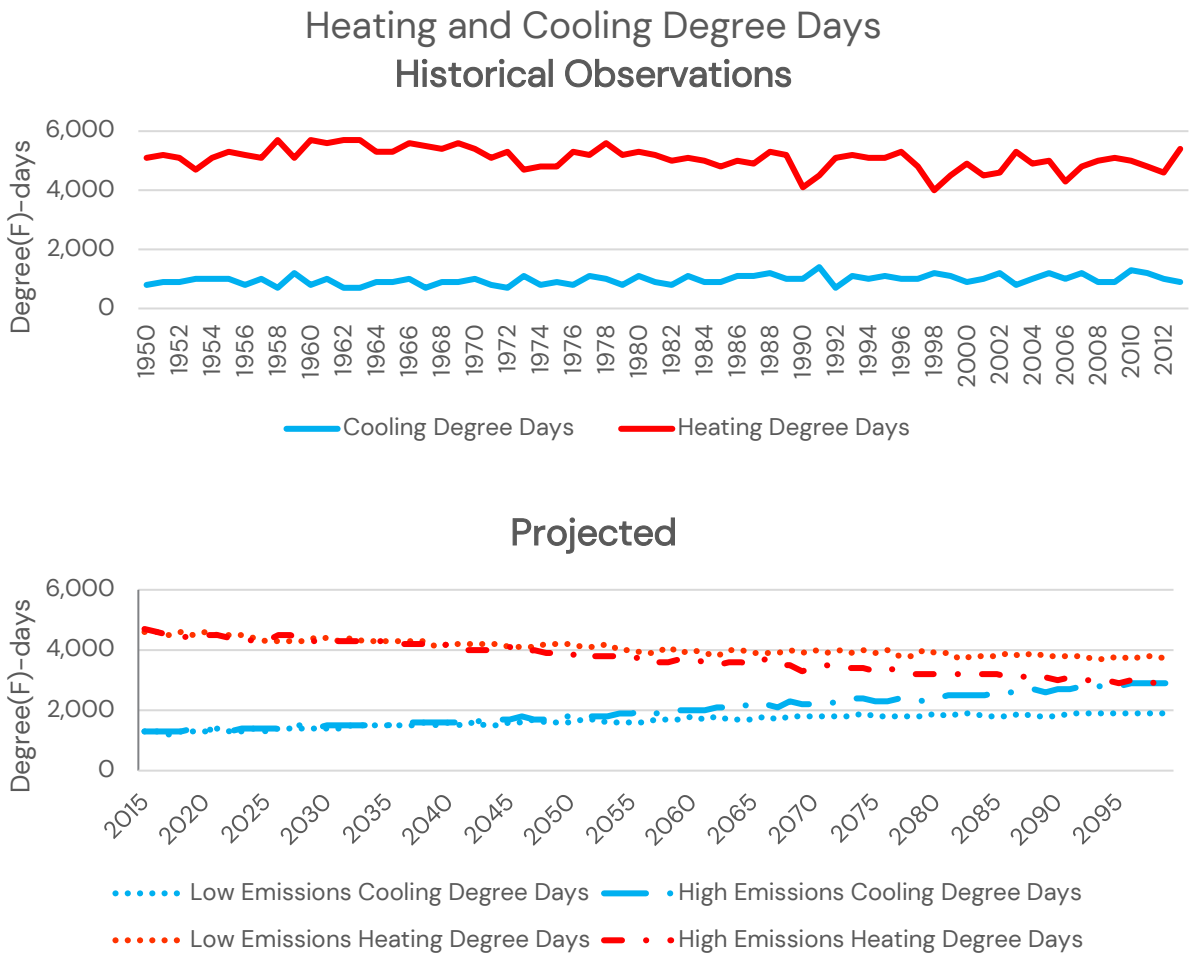
The County is expected to see an **increase in the number of cooling degree days and a decrease in the number of heating degree days**. Degree days are related to the difference between the daily average temperature and 65°F. Cooling degrees days occur if the average temperature is above 65°F, and heating degree days are days where the average temperature is below 65°F.[25] The number of days colder than 65°F is

[25] Units for heating and cooling degree days are in degree days, which are the number of degrees above or below 65°F per day. To calculate heating degree days (HDD), the mean temperature is subtracted from 65°F. To calculate cooling degree days (CDD), 65°F is subtracted from the day's mean temperature. For example, if the mean temperature for a day was 78°F, we would calculate cooling degree days because it is above 65°F. We would subtract 65 from 78 to get 13, so that day has 13 cooling degree days.

To find total HDD or CDD for a month, the degree days for each day are added together. The more extreme the higher or lower temperature, the higher the number of degree days.

projected to decrease as global temperatures rise, while the number of days each year warmer than 65°F is projected to increase (Figure 20). This has implications for energy use as residents in Frederick County will use less energy to warm their homes but more energy to cool them. These projections support the long-term trend observed in the temperature graphs (Figures 19 and 20) that the average temperature is getting warmer, leading to more days over 65°F and fewer below 65°F.

Figure 20: Heating and Cooling Degree Days in Frederick County, MD. Top graph shows historical annual average heating and cooling degree-days from 1950 to 2013. The bottom graph shows projected heating and cooling



4.3.6 Precipitation

Climate change projections do not show a large change in the overall amount of average annual precipitation but do reveal a slight increasing trend. Figure 21 shows the historical and projected average annual precipitation in the County. Under a high emissions scenario, **the County could receive 46.3 inches of precipitation per year by 2090, approximately two to six more inches than the historical annual average of 40 to 44 inches per year.**

Frederick County is projected to experience more precipitation falling in short-duration, high-intensity precipitation events. **This means it will rain less frequently, but when it does rain, it will be a heavier rain event.** While under a low emissions scenario there is a slight (4%) projected decrease in number of days with more than three inches of rain by 2050, under a high emissions scenario the annual number days with more than three inches of precipitation are projected to increase from the historical average of 0.1 days by 10% (Figure 22). By 2090, the annual number of days with more than three inches of precipitation are projected to

increase by 15% (to 0.12 days) in the low emissions scenario and by 37.5% (to 0.16 days) in the high emissions scenario.

Figure 21: Average annual historical (1950-2013) and projected (2014-2050) precipitation in Frederick County, MD. Red and blue fill indicates the range of future projected values under high and low emissions scenarios, respectively. Red and blue lines show the weighted means of projections for high and low emissions scenarios, respectively. Source: NOAA Climate Explorer.

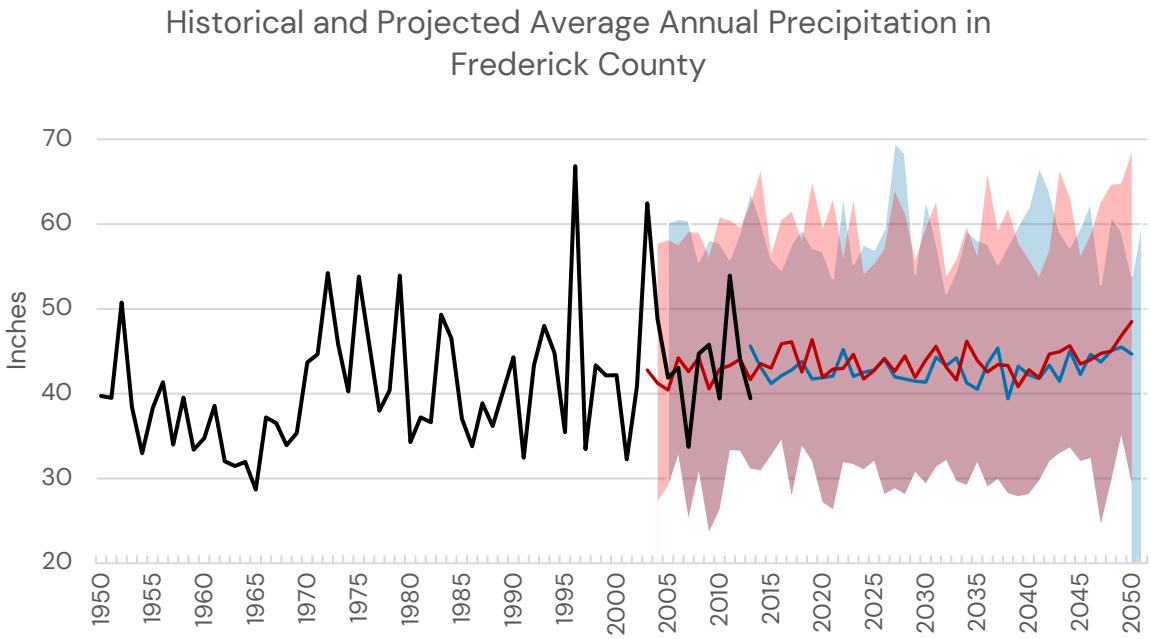
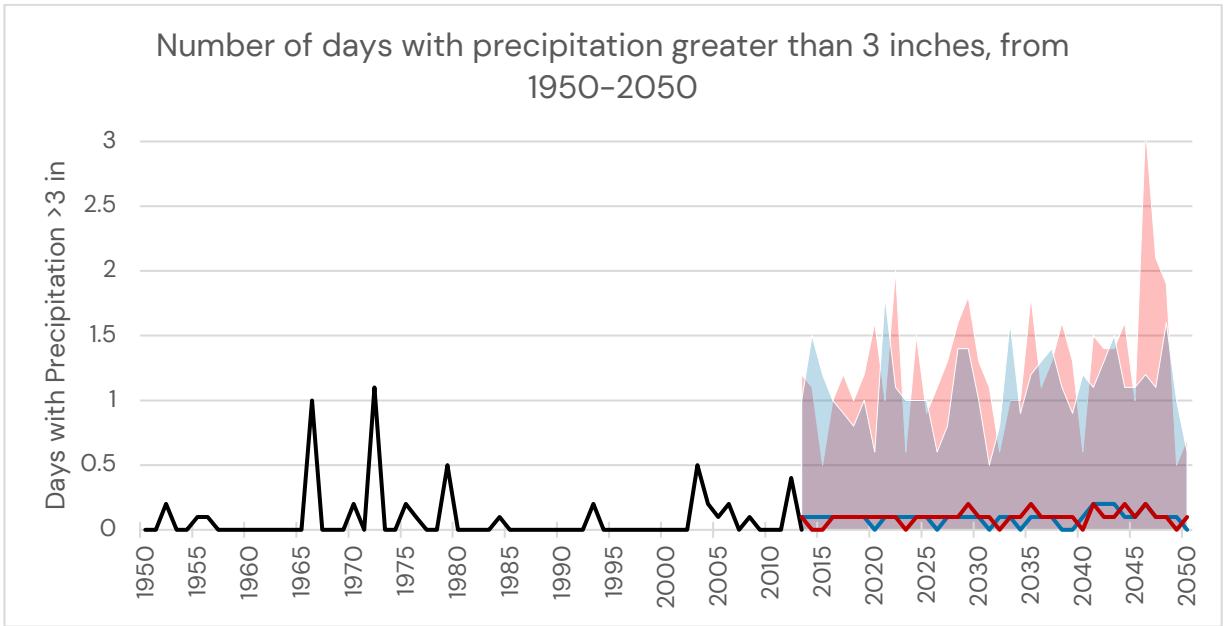


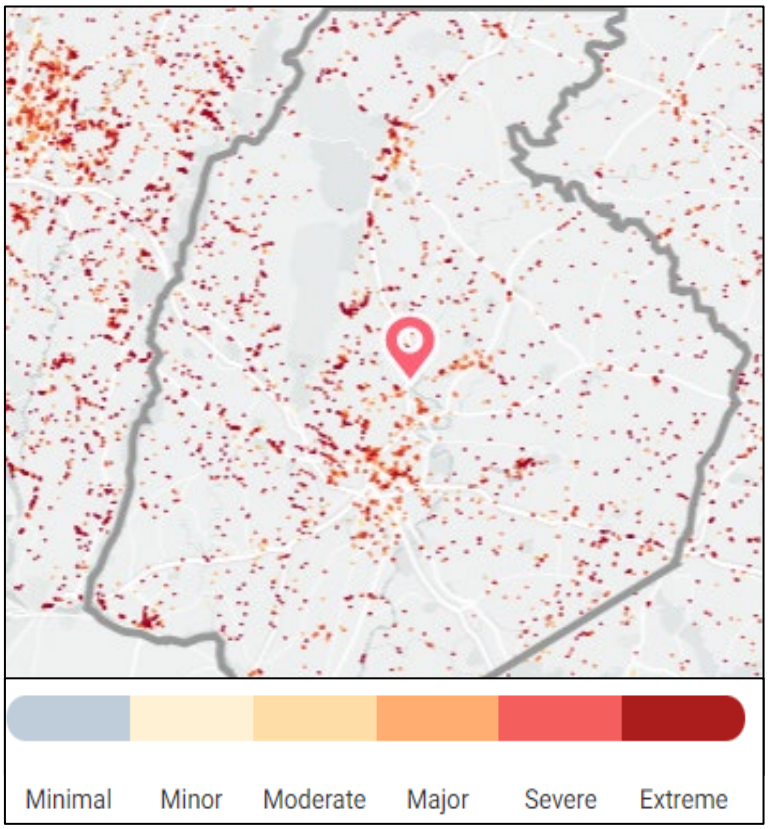
Figure 22: Number of days each year with precipitation over three inches in Frederick County, MD. Red and blue fill indicates the range of future projected values under high and low emissions scenarios, respectively. Red and blue lines show the weighted means of projections for high and low emissions scenarios, respectively. Source: NOAA Climate Explorer.



4.3.7 Flooding

Riverine flooding or flash flooding after heavy rainfall are the primary flood types of concern for Frederick County. *Riverine flooding* occurs when rainfall or snowmelt exceeds the capacity of river or stream banks and overflows into floodplain area. *Flash flooding* is a rapid rise of water along a water channel or low-lying urban area, usually as the result of an unusually large amount of rain or high velocity of water flow within a very short period of time.[26] Since 1953, there have been 13 major storm disaster declarations for Frederick County, nine of which were for severe storms and consequent flooding.

Figure 23: Areas in Frederick County, MD vulnerable to flooding in the next 30 years. Source: First Street Foundation's Flood Factor.



There are several components of climate change that are projected to drive increased flooding. A warmer atmosphere holds more water vapor, which increases the potential for heavier rainfall. In addition, as mentioned in the precipitation discussion above, rainfall events are projected to become more intense, with a slight increase in the number of days per year with precipitation over 3 inches. Additionally, while the number of hurricanes each year is not projected to change, more hurricanes are expected to be Category 3 or stronger.[27]

Highly detailed flood risk mapping from the First Street Foundation's Flood Factor predicts that by midcentury, over 4,000 buildings in Frederick County could be severely affected by flooding (Figure 23).[28] These properties have a greater than 26% chance of being flooded in the next thirty years, which the Federal Emergency Management Agency (FEMA) defines as high risk. Of these, most are residential properties. These calculations take climate factors into account such as future intense precipitation events, as well as development patterns and flood control measures. Such factors are not currently part of FEMA's flood projections.

4.3.8 Winter Storms

Precipitation is projected to increase in the winter months, and due to increased temperatures under a changing climate, a greater portion of the precipitation will fall as rain rather than snow in the colder seasons.[29]

---

[26] Federal Emergency Management Agency (FEMA). Wright, James. 2007. "Chapter 2: Types of Floods and Floodplains" in *Floodplain Management: Principles and Current Practices*. Available at: https://training.fema.gov/hiedu/aemrc/courses/coursetreat/fm.aspx

[27] Dupigny-Giroux et al. 2018. "Northeast." In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. U.S. Global Change Research Program, Washington, DC. Available at: https://nca2018.globalchange.gov/chapter/18/.

[28] First Street Foundation. 2020. Flood Factor. Accessed February 28, 2022. Available at: https://www.floodfactor.com/county/frederick-county-maryland/24021_fsid

[29] Dupigny-Giroux et al. 2018

However, **the intensity of extreme winter storms, including nor'easters and extreme cold snaps, is projected to increase through the end of the century due to climate change.** During the 2013/14 and 2016/17 winters, "polar vortex" events in the northeast United States led to freezing conditions in Frederick County.[30] Climate change could possibly cause more frequent and persistent weakened polar vortex events, when cold air normally confined to the Arctic is released to the continental United States, leading to cold weather extremes—though this is not a certainty.[31] However, there is stronger evidence for the connection between climate change and an increase in the frequency and intensity of storms, which includes winter storms.[32] The 2022 Hazard Mitigation and Climate Adaptation Plan estimates that Frederick County experiences 10 to 11 severe winter events each year, up from 6 to 7 in the 2017 Hazard Mitigation Plan. Severe events occur when the main type of precipitation is snow, sleet, or freezing rain,[33] and can lead to freezing conditions such as those experienced during the extreme winter storms in 2013 and 2017. Strong winds often accompany winter storms, threatening to topple power lines and trees.

4.3.9 Drought

Although the total annual precipitation is projected to increase, the risk of drought is expected to grow through the end of the century due to warming temperatures, earlier snowmelt, and precipitation variability.[34] This is especially concerning for agriculture, since higher temperatures increase the rate of soil moisture loss during drought periods. About 45% of Frederick County is made up of farmland, which constitutes 10% of Maryland's farm area.[35,36] The County experienced 12 drought periods from 1950 to 2021.[37] Drought events since 1993 produced roughly $40.2 million in crop damages; on average, Frederick County experiences about $1.5 million annually in drought-related crop damages.[38] The County has experienced two extreme droughts since 2000: one from 2001 to 2003 that consisted of the second driest 12 months in Maryland history and another in 2007. There have not been any significant droughts since 2007, though the severity and frequency of droughts is projected to increase.[39,40]

4.4 Social Vulnerability

The impacts of climate change are not distributed equally. This leads to equity implications for division services and operations under changing climate conditions. **Minority, disabled, elderly, youth, and low-income populations are more at risk** because they may have a difficult time recovering from property damage and interruptions in school or employment, affording repairs or relocation costs, or accessing necessary health

[30] City of Frederick Climate Action Plan. 2021.
[31] Lindsey, Rebecca. 2021. Understand the Arctic polar vortex. NOAA. Accessed June 30, 2022. https://www.climate.gov/news-features/understanding-climate/understanding-arctic-polar-vortex
[32] Hayhoe, K., D.J. Wuebbles, D.R. Easterling, D.W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose, and M. Wehner, 2018: Our Changing Climate. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144. doi: 10.7930/NCA4.2018.CH2
[33] NOAA National Severe Storms Laboratory. 2022. Severe Winter Weather 101. Accessed April 24, 2022.
[34] U.S. Global Change Research Program. 2018. Fourth National Climate Change Assessment: Chapter 2: Our Changing Climate. Available at: https://nca2018.globalchange.gov/chapter/2/.
[35] 2017 Census of Agriculture
[36] National Integrated Drought Information System (NDIS) "Drought Conditions for Frederick County", Accessed February 2022. Available at: https://www.drought.gov/states/maryland/county/frederick.
[37] National Centers for Environmental Information (NCEI)
[38] Frederick County Hazard Mitigation and Climate Adaptation Plan (2022).
[39] Hayhoe et al. 2018.
[40] Scientific and Technical Working Group. 2008. Comprehensive Assessment of Climate Change Impacts in Maryland: Report to the Maryland Commission on Climate Change. https://mde.maryland.gov/programs/Air/ClimateChange/Documents/FINAL-Chapt%202%20Impacts_web.pdf

or social services after extreme weather events. Minority and low-income communities are often more exposed to climate risks, such as living in areas with less tree cover, which has been linked to higher average temperatures. This is due to several compounding factors, including historic zoning and housing practices,[41] a lack of political influence, and limited financial means to relocate or invest in resilient infrastructure. On the zoning and housing front, banks and other entities denied funding to refinance after the Depression to minorities specifically due to race and ethnicity, which impacted where these populations were able to secure housing, leading to inequitable housing patterns that persist to this day.

Table 10: Demographic Characteristics in Frederick County that Contribute to Climate

Frederick County Demographics	
Below poverty line	5.7%
With a disability	10.5%
Without health insurance	5.5%
Median household income	$97,730
Persons 65 and older	14.8%
Minority	25.7%

Though all climate hazards pose risks to vulnerable populations, extreme heat is especially important to monitor because it is more deadly than any other hazard, including flooding, hurricanes, and tornadoes.[42] Given that the number of days over 90°F is projected to increase dramatically by 2050 (as shown in Figures 18 and 19), the exposure of these communities to extreme heat is important to take into consideration. The Occupational Safety and Health Administration (OSHA) heat index guidelines indicate that temperatures from 91°F to 103°F pose a moderate risk to outdoor workers.[43] Additionally, people with underlying health conditions or who live in poorly ventilated buildings are more prone to heat related stress, illness, and death.

4.4.1 How to Measure Social Vulnerability

The vulnerability of different groups to the consequences of climate change depends on three primary factors:

- Their **exposure** to climate risks,
- Their **sensitivity** to climate change impacts, and
- Their ability to adapt, or **adaptive capacity**, to these climate change impacts.

Exposure refers to the degree to which a communities, systems, assets, or individuals will experience a climate change hazard when it occurs, while **sensitivity** refers to the degree to which they are affected, either adversely or beneficially, by climate variability or climate change.[44] For example, a community center that is closer to a riverbed may be more exposed to flooding hazards than one that exists on higher ground. A road that was designed and built to fully accommodate runoff may be less sensitive to flooding damage or washout than a road that has not had stormwater upgrades. Finally, **adaptive capacity** refers to the existing tools, capabilities, resources, and institutions that can help communities, systems, assets, or individuals respond and adapt to climate change. Examples of adaptive capacity can include robust social services or financial elements like insurance.

---

[41] Van Slyke, Ashley. 2020. *America's Legacy of Redlining: State Sponsored Segregated and Disenfranchisement of Urban Minority Communities*. Lerner Center Issue Brief #35, Syracuse University. Available at: https://lernercenter.syr.edu/wp-content/uploads/2020/07/VanSlyke_Redlining_Final.pdf

[42] U.S. EPA. "Climate Change Indicators: Heat Related Deaths". Last updated October 2021. Available at: https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths#ref10.

[43] OSHA. N.d. "Using the Heat Index: A Guide for Employers." Available at: https://www.osha.gov/SLTC/heatillness/heat_index/

[44] Adapted from Intergovernmental Panel for Climate Change, 2007. "Fourth Assessment Report: Annex I." Available at: https://archive.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_appendix.pdf

The character, magnitude, and rate of climate variation also affects vulnerability.[45] The previous sections detailed Frederick County's *exposure* to climate hazards, with the most critical changes being increases in extreme heat and flooding. **Communities of color and low-income areas are often more *sensitive* to the impacts of climate change.** For example, these communities are more likely to have less vegetation, higher land surface temperatures, and more impervious surfaces—all of which can lead to an increased risk of flooding and contribute to the urban heat island effect.[46] To assess the *adaptive capacity* to climate change impacts, the Center for Disease Control (CDC) and the U.S. Census Bureau use demographic and economic characteristics to estimate the ability of communities to recover from and adapt to extreme events. Additionally, ALICE—which stands for *Asset Limited, Income Constrained, Employed*—measures the number of households struggling financially. These households have incomes above the Federal Poverty Level but below a basic survival threshold, defined as the ALICE Threshold. In 2018, 95,903 households (37%) in Frederick County were below the ALICE threshold.[47] These households may have more trouble affording electricity for air conditioning and other measures to protect themselves from extreme heat.

4.4.2 Areas of Social Vulnerability in Frederick County

The CDC Social Vulnerability Index (SVI) rates the vulnerability of census tracts on a scale of 0 to 1 based on four categories — socioeconomic, household composition, minority status, and housing type and transportation — that take different variables into account, with higher scores denoting greater vulnerability. The factors included in the Index's calculations focus on elements that weaken a community's ability to prevent human suffering and financial loss in a disaster, including poverty, lack of access to transportation, and crowded housing. Frederick County has an estimated population of 271,717.[48] **An estimated 10.5% of the population is living with a disability, 14.8% is over 65 years, and 5.7% lives below the poverty line.**[49] The average SVI score for the County is 0.16, which is lower than the national average, indicating that overall, the County's community is less vulnerable to climate impacts than the average county in the United States.

A second method of measuring risk is from Headwater Economics' Neighborhoods at Risk report, which identifies census tracts where vulnerabilities to climate change exceed the County median. The method uses many of the same variables as the CDC social vulnerability index, including non-native English speakers, children under five years, people of color and Hispanic populations, households with no car, people aged 65+ years, and people with disabilities. In addition to socioeconomic variables, the Headwater Economics method considers climate exposure variables, including impervious surfaces, area without tree canopy cover, number of properties with flood risk, and area in a floodplain. This method identified **15 census tracts in Frederick County likely to be highly at risk to the effects of climate change** (Figure 24).[50]

---

[45] Bierbaum, R., A. Lee, J. Smith, M. Blair, L. M. Carter, F. S. Chapin, III, P. Fleming, S. Ruffo, S. McNeeley, M. Stults, L. Verduzco, and E. Seyller. 2014. "Ch. 28: Adaptation. Climate Change Impacts in the United States: The Third National Climate Assessment.". U.S. Global Change Research Program. Available at: https://nca2018.globalchange.gov/chapter/28/.

[46] Madrigano J, Ito K, Johnson S, Kinney PL, Matte T. 2015. "A case-only study of vulnerability to heat wave–related mortality in New York City (2000–2011)". Environ Health Perspectives. Available at: 123:672678; http://dx.doi.org/10.1289/ehp.1408178

[47] United for ALICE. 2020. *Alice in Maryland: A Financial Hardship Study,* https://www.unitedforalice.org/.

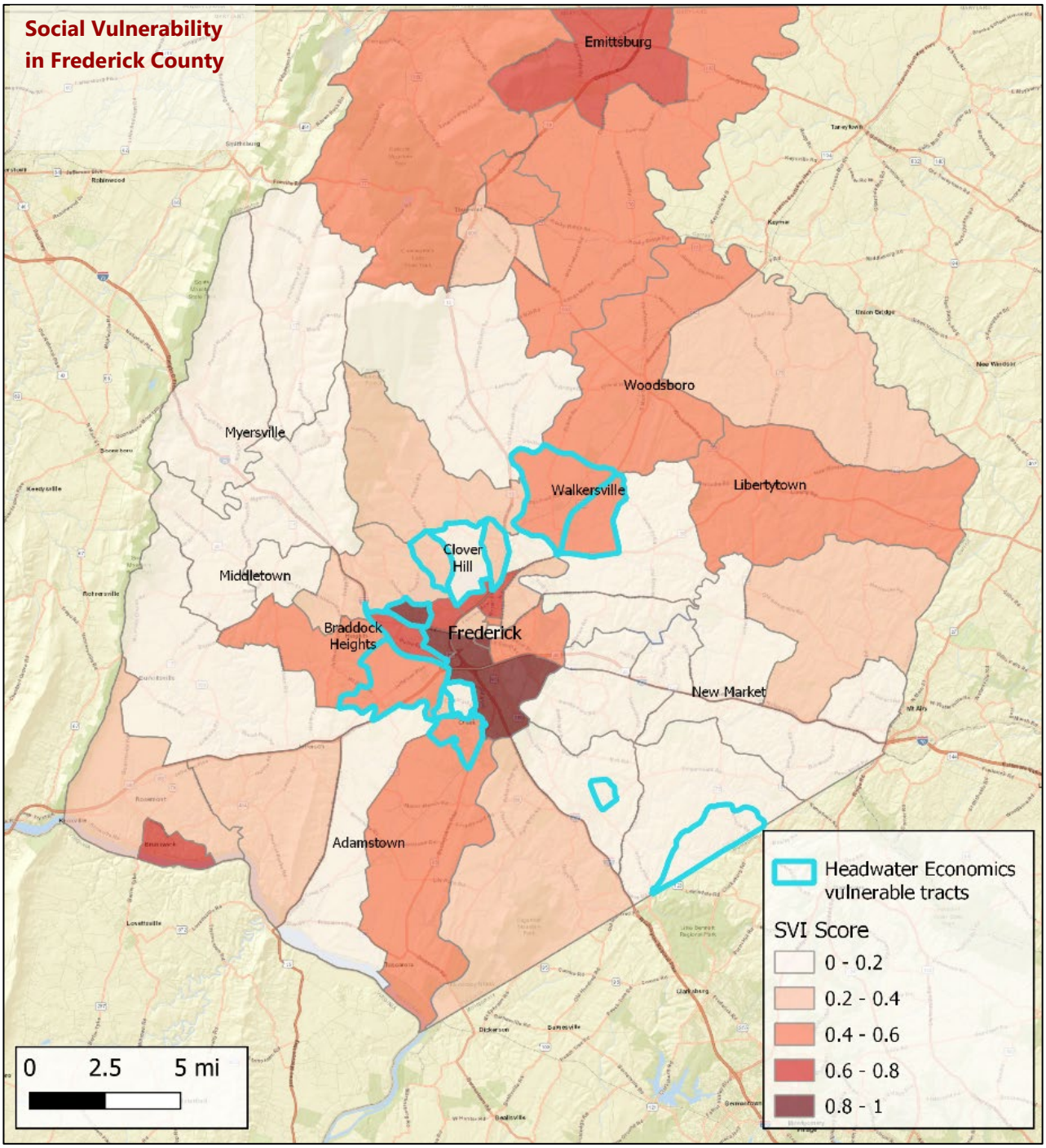
[48] U.S. Census Bureau. "Quick Facts for Frederick County, Maryland". 2020. Available at: https://www.census.gov/quickfacts/frederickcountymaryland.

[49] Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program. 2018. CDC/ATSDR Social Vulnerability Index. Database Maryland. Accessed on November 24, 2021. Available at: https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html.

[50] Headwater Economics. 2022. "Populations at Risk: Maryland". Prepared for the U.S. Census Bureau, American Community Survey Office, Washington, D.C. Available at: headwaterseconomics.org/par.

Since both methods use different variables and techniques to identify vulnerable communities, they did not identify the same census tracts as being highly vulnerable. However, risk measurements such as the CDC SVI and Headwater Economic's analysis illustrate the ability of communities within Frederick County to adapt when confronted with external stresses, such as natural disasters, human caused disasters, or disease outbreaks. This information is particularly useful when identifying areas that should be targeted for investments in resilience.

Figure 24: Social vulnerability scores for census tracts in Frederick County based on the Center for Disease Control's Social Vulnerability Index and the Neighborhoods at Risk's evaluation. Source: CDC SVI and Headwater Economics.



4.5 Climate Impacts and Consequences: High-Consequence Risks

Using the future climate conditions described in Section 4.3: The Climate is Changing above, the study team assessed how flooding, extreme heat, winter storms, and drought could affect FCG assets, operations, and services. This resulted in a preliminary list of climate risks for FCG. Informed by input from County divisions, the study team refined this preliminary list and identified high-consequence climate risks. In this context, ***high-consequence risks*** are those that could result in severe injury or death; halt normal operations; require replacement of an asset; and/or significantly add costs beyond the division's expected budget.

After identifying high-consequence risks in each sector, ICF determined that **flooding and heat present the greatest level of risk to FCG**, as these climate hazards currently present a high level of risk and are expected to present markedly higher levels of risk in the future due to climate change, particularly extreme heat. As such, the priority risks for each sector are related to flooding and heat. Table 11 summarizes the priority risks for each sector.

Overall, the study team found that the priority risks for flooding include interruptions to County services and use of County assets; damage to infrastructure; and human health impacts. The priority risks for heat include negative impacts to human health and stress to County infrastructure. In addition, both flooding and heat create the need for backup power across County divisions.

The sector-by-sector discussion in the subsections that follow go into more detail on these priority risks, as well as high-consequence risks due to winter weather and drought. Section 4.6: Climate Impacts and Consequences: Other Risks presents the additional risks that the study team and divisions identified but did not deem to be high-consequence.

Table 11: Frederick County Government Sectors, Divisions, and Asset Classes/Services Discussed in this CRVA

Sector	County Divisions	Asset Classes, Operations, and Services	Priority Risks
Water, sewer	Water and Sewer Utilities	Potable water system (mains, pumps, treatment plants) Sewer system (mains, pumps, treatment plants, outfalls) Water sources (groundwater; Potomac River; reservoirs)	Flooding: Sewer facilities flooding; water supply contamination; damage to water treatment plants. Heat: electric grid outages; damage to wastewater treatment plant electric equipment; increased evaporation.
Stormwater	Stormwater (within Energy and Environment)	Stormwater system (storm drains/culverts, outfalls, mains/pipes)	Flooding: Flows exceeding infrastructure capacity; pollutants running off into waterbodies.
Emergency Management and Response	Fire and Rescue Services Emergency Management	Emergency vehicles Fire stations Emergency response	Flooding: Impassable roads; inhibiting emergency response; increased need for rescues. Heat: Negative impacts on health of citizens and responders; increased heat-related health emergencies; stress on operating limits for vehicles.
Transport	TransIT Services Public Works	Public transit Paratransit County highways, roads, and sidewalks Bridges Fleet	Flooding: Damage to infrastructure and fleet; difficulty for users to access transportation (especially paratransit); impassable roads. Heat: Transit vehicles and operators overheating; heat stress and health impacts to passengers waiting for transit services, cyclists, and pedestrians.
Natural and Cultural Resources	Parks and Recreation Agriculture Energy and Environment	Parks, nature centers, and picnic centers Recreation centers, gyms, and athletic venues Historic sites and grounds Agricultural land Sustainability and watershed management services	Flooding: Increased stormwater pond inspections, repair, and maintenance; damage to parks; staffing constraints for re-opening parks; and damage to irreplaceable cultural and historic assets. Heat: Low success for tree plantings and wetlands; decreased revenue; decreased participant safety; reduced workdays due to County heat stress policies.
Information and Comms. Technology	Interagency Information Technologies	Data center IT services	Flooding: Knocking out backup generators and disrupting services, higher costs to cool data centers.

Sector	County Divisions	Asset Classes, Operations, and Services	Priority Risks
Buildings	Public Works Solid Waste and Recycling	Utilities County facilities Landfill	Flooding: Damaged facilities; landfills experiencing slope failure, facility closures, and spread of contaminants. Heat: Power outages; damage to contamination control at landfills.
People and Health	Citizens Services Senior Services Sheriff's Office Health	Provision of low or no cost person-centered housing, human services, and community resources Senior Center Detention Center Public Health Department and healthcare services	Flooding: Negative impacts to human health (physical and mental); contamination of water supply; interruptions in County services; changes to the water table affecting seasonal testing for septic system suitability; flooding private wells, negative impacts to food supply. Heat: Negative impacts to human health, including to County employees who work outdoors; equity implications for disadvantaged populations being particularly susceptible to heat impacts; reduced air and water quality; and high ozone days.
Economy	County Executive (grants/economic development) Economic Development Finance	County services related to economic development	Flooding: Increased County expenses; potentially increased insurance premiums Heat: Negative impacts to outdoor workers' health and productivity; reduced agricultural revenue and jobs.

4.5.1 Water and Sewer

The water and sewer sector is comprised of one division, shown in Table 12, with sector-specific high-consequence risks due to climate hazards listed after.

Table 12: County Divisions and Corresponding Asset Classes and Operations in the Water and Sewer Sector

County Divisions	Asset Classes and Services
Water and Sewer Utilities	Potable water system (mains, pumps, treatment plants) Sewer system (mains, pumps, treatment plants, outfalls) Water sources (groundwater; Potomac River; reservoirs)

The County identified potential high-consequence risks to the water and sewer sector due to all climate hazards (i.e., flooding, extreme heat, winter storms, and drought).

High-consequence risks from flooding include sewer facilities, typically located at the lowest elevations, being prone to flooding and resulting in overflows or loss of facility function. Flooding can also impact water facilities, leading to water supply contamination or loss of facility function.

Extreme heat could indirectly affect the water sector by causing brownouts or blackouts in the electrical grid, which could result in loss of service or water pressure for the potable water system. High temperatures could also damage electric equipment at wastewater treatment plants. Finally, increased temperatures lead to more evaporation, which, in combination with drought, can deplete the surface water supply, which makes up about 90% of the County's supply.

Winter storms, like extreme heat, can impact the potable water system indirectly by disrupting the electric grid, resulting in a loss of service or water pressure. Extreme weather can also lead to supply chain issues for treatment chemicals or fuel, which could interrupt the normal provision of potable water.

Finally, the high-consequence risk from **drought** is to the potable water system. In the most extreme situation where the water facility cannot operate, low flows may result in loss of system pressure.

All the risks described above could increase risks to public health and disrupt the provision of water and sewer services.

The 2022 Hazard Mitigation and Climate Adaptation Plan also identified risks to the water and sewer sector. These include flooding overwhelming and damaging water treatment plants and winter storms causing water utility infrastructure to freeze. Higher temperatures can lead to drought, putting strain on the County's water resources.

4.5.2 Stormwater

The stormwater sector encompasses the division shown in Table 13, with sector-specific high-consequence risks due to climate hazards listed after.

Table 13: County Divisions and Corresponding Asset Classes and Operations in the Stormwater Sector

County Division(s)	Asset Classes and Services
Stormwater (within Energy and Environment)	Stormwater system (storm drains/culverts, mains/pipes, outfalls)

The stormwater system will experience high-consequence risks from flooding. Increases in the frequency and intensity of strong rains means that the County's stormwater infrastructure capacity will be exceeded more frequently during storms, which could carry risks to public health and safety. Further, stormwater drainage conveyance systems in the County are typically directly connected or flow to waterbodies, which means that pollutants in runoff can enter directly into waterbodies without treatment, negatively impacting human and environmental health.

On the other hand, **severe drought conditions** will negatively impact small-scale stormwater practices and carry the potential to dry larger stormwater ponds, which could cause fish kills. In addition, the 2022 County Mitigation Hazard and Climate Adaptation Plan indicated that areas with stormwater drainage issues are vulnerable if heavy precipitation follows a period with drought conditions.

4.5.3 Emergency Management and Response

– The emergency management and response sector encompass the divisions shown in Table 14, with sector-specific high-consequence risks due to climate hazards listed after.

Table 14: County Divisions and Corresponding Asset Classes and Operations in the Emergency Management and Response Sector

County Division(s)	Asset Classes and Services
Fire and Rescue Services	Fire stations and vehicles
Emergency Management	Emergency vehicles Emergency response

Climate change will undoubtedly increase the demand for emergency management and services in response to extreme weather impacts. As will be discussed further in the Resiliency Strategies section, proactive climate adaptation measures—which help reduce vulnerabilities over the long-term that would otherwise result in short-term emergency response—will help to reduce mounting impacts to this sector under a changing climate.

Greater **extreme heat** days in the future will affect the health of responders, as well as require greater response to emergency public health needs. Additionally, extreme heat will stress the safe operating limits for emergency response vehicles.

The 2022 County Hazard Mitigation and Climate Adaptation Plan indicated **winter storms and flooding** events can cause roads to become impassable, inhibiting emergency responders and equipment to reach areas in need. Increases in the frequency and severity of **flooding** will increase the need for rescue during flood events. Additionally, increased prevalence of **ice and heavy snow** during extreme winter events can contribute to power outages, requiring emergency response. The county keeps records of 911 calls, road closures, water rescues, and other flooding related data.

4.5.4 Transportation

The transportation sector encompasses the divisions shown in Table 15, with sector-specific high-consequence risks due to climate hazards listed after.

Table 15: County Divisions and Corresponding Asset Classes and Operations in the Transportation Sector

County Division(s)	Asset Classes and Services
TransIT Services	Public transit Paratransit
Public Works	County highways, roads, and sidewalks Bridges Fleet

The County identified potential high-consequence risks to the transportation sector for flooding, extreme heat, and extreme winter weather.

Future increases in frequency and intensity of **flooding** may lead to greater damages of transportation and public transit infrastructure (such as through pavement washouts, clogged drainage, and debris), which can lead to increased frequency of delays, decreased safety and reliability, and increased costs of maintenance and repair. Flooding can damage the transit fleet, which can increase costs and interrupt service. Additionally, flooding can present difficulty for users to access paratransit during severe weather.

The 2022 County Hazard Mitigation and Climate Adaptation Plan identified that storm runoff may overwhelm various culverts and bridges throughout Frederick County, which could make roads and bridge impassable. Debris from floods can cause road damage or bridge collapse. Flooded roadways can cause congestion on alternative routes and lengthen travel times. In August 2018, flash flooding from Sams Creek scoured out a

portion of Oak Orchard Road and Sams Creek Road, and other roads were closed due to flooding. In July 2019, 20 different roadways were flooded and closed for several hours after a strong storm. In August 2021 a school bus was stranded in rising floodwaters from Hurricane Ida.

Greater **extreme heat** days in the future can affect transportation and transit infrastructure, operations, and users that the County serves. Extreme heat can overheat transit vehicles and operators. Heat can also stress passengers waiting for transit services, cyclists, and pedestrians.

Similarly, **winter storms** will also affect transportation and transit infrastructure, operations, and users that the County serves. Heavy snow on roads can lead to delays, interrupt transit service, and present difficulty for users to access paratransit. Extreme cold can affect diesel fuel and electric efficiency, leading to operational impacts for Public Works' and TransIT's diesel and electric fleets. Lastly, extreme storms (including severe thunderstorms) affect transit riders' access to safe sheltering depending on location, and limit mobility options for pedestrians and cyclists.

The 2022 County Hazard Mitigation and Climate Adaptation Plan also identified that there is a high probability for traffic accidents and traffic jams during heavy snow and light icing events. Transportation delays and disruptions to power distribution networks during winter storms can make getting help to those affected more difficult, which can increase risks to public health and safety.

4.5.5 Natural and Cultural Resources

The natural and cultural resources sector encompasses the divisions shown in Table 16, with sector-specific high-consequence risks due to climate hazards listed after.

Table 16: County Divisions and Corresponding Asset Classes and Operations in the Natural and Cultural Resources Sector

County Division(s)	Asset Classes
Parks and Recreation	Parks, nature centers, and picnic centers Recreation centers, gyms, and athletic venues Historic sites and grounds
Agriculture	Agricultural land
Public Works Stormwater Program	Watershed management services

Natural and cultural resources in Frederick County face high-consequence risks from all four priority hazards.

For parks, increased **flooding** means increased stormwater pond inspections, repairs, and maintenance. Flooding can also damage parks, creating budget issues for repairs. Staffing issues can also result from increased work to reopen parks after a flood event.

Extreme heat can affect both this sector's assets and operations. On the assets side, increased temperatures can result in low success rates on tree planting areas and wetland areas. On the operations side, extreme heat can decrease revenue and participant safety due to the risk that extreme heat poses to human health. This health risk also results in reduced workdays due to the County heat stress policies (Figure 25). For example, if the wet bulb globe temperature[51] is 85□F, then acclimatized workers can perform light work at 100% capacity,

[51] Wet bulb Globe Temperature is a measure of the heat stress in direct sunlight, taking into account temperature, humidity, wind speed, sun angle, and cloud cover (solar radiation). It is used by many agencies to monitor work and exercise in direct sunlight. Source: NOAA Weather Forecast Office. 2022. WetBulb Globe Temperature. Accessed April 24, 2022.

but moderate work at 50% capacity, with 50% of time devoted to rest; this shifts to 25% work and 75% rest under very heavy work demands. If wet bulb globe temperatures are above 90□F, then acclimatized workers can only perform light work at 25% capacity, with 75% of time devoted to rest. These thresholds are even lower for workers who are not yet acclimatized to heat conditions, which takes several days. As described in 4.3.4: Extreme Heat, the number of days with extreme heat are projected to greatly increase due to climate change.

Figure 25: Screening Criteria for Heat Stress Exposure based on Wet Bulb Globe Temperature adapted from FCG's Standard Operating Procedures during Periods of High Heat Stress & Strain.

Work Demands	Acclimatized				Un-acclimatized			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	**85°F**	**82°F**	**79°F**	**-**	**82°F**	**77°F**	**73°F**	**-**
75% Work 25% Rest	**87°F**	**83°F**	**82°F**	**-**	**84°F**	**80°F**	**76°F**	**-**
50% Work 50% Rest	**89°F**	**85°F**	**83°F**	**82°F**	**86°F**	**82°F**	**80°F**	**77°F**
25% Work 75% Rest	**91°F**	**88°F**	**86°F**	**85°F**	**88°F**	**84°F**	**82°F**	**80°F**

Winter storms can increase costs for County divisions, both through normal response activities as well as in response to damage. Increased frequency and intensity of winter storms leads to more salt usage, higher staffing costs to ensure parks are reopened in a reasonable amount of time, and the need to procure vehicles that are rated for the task of snow and ice removal. In addition, high winds and ice accumulation can cause damage to trees and landscapes. Finally, increased use of salt and ice melt can harm turf and landscape areas.

Drought is a concern for natural assets. Specifically, drought can inhibit reforestation efforts by drying the soil and jeopardizing recent tree plantings; and can also lead to excessive wear on grass turf fields.

The 2022 Hazard Mitigation and Climate Adaptation Plan identifies cultural resources that are at risk to **various climate hazards**, indicating that these "cultural and historic assets [that are] often the most unique and irreplaceable buildings and places in communities" should be prioritized in County planning.

4.5.6 Information and Communications Technology

The information and communications technology sector encompasses the divisions shown in Table 17, with sector-specific high-consequence risks due to climate hazards listed after.

Table 17: County Divisions and Corresponding Asset Classes and Operations in the Information and Communications Technology Sector

County Division(s)	Asset Classes and Services
Interagency Information Technologies (IIT)	Data center IT services

The IIT division reported that **flooding poses the biggest threat to their assets and operations**. Their services rely on functioning backup generators; flooding may knock out such generators. Flooding resulting in power outages and a loss of backup power would disrupt services (email, stored data, information access, etc.) throughout the County and could halt normal operations for the division. An extended power outage beyond

the capacity for backup generation, or with the loss of backup power, would affect both IIT's and 911 Center's data centers, which presents a large risk.

In addition, the 2022 Hazard Mitigation and Climate Adaptation Plan indicated that during **winter storms or flash flooding**, winds and ice can damage telecommunications lines and other overhead infrastructure.

4.5.7 Buildings and Facilities

The buildings and facilities sector encompasses the divisions shown in Table 18, with sector-specific high-consequence risks due to climate hazards listed after.

Table 18: County Divisions and Corresponding Asset Classes and Operations in the Buildings and Facilities Sector.

County Division(s)	Asset Classes
Public Works	Utilities County facilities
Solid Waste and Recycling	Landfill

Flooding presents the greatest threat to the buildings and facilities sector, though there are also high-consequence risks from extreme heat and winter storms.

Flooding can damage County facilities via roof leaks; temporary inundation; destruction of building materials such as carpet, wood flooring, and insulation; and potential sump pump failures, which can increase water intrusion in lower levels of facilities. At County landfills, flooding has the potential to reduce the stability of the slopes and overwhelm leachate collections systems, which would result in slope failures, facility closures, and spread of contaminants into the soil and waterways.

The 2022 Hazard Mitigation and Climate Adaptation Plan (HMCAP) states that all buildings, including critical facilities, are susceptible to flood damage and could collapse if exposed to a severe flood. Modeling from the 2022 HMCAP suggests that 4.2% of all buildings in Frederick County will be exposed to flooding for the 10-year 24-hour flood event and 6.9% of all buildings will be exposed to the 100-year 24-hour flood event. Of these buildings, 53 are critical sites, including facilities for the Frederick County Department of Public works and two branches of the Frederick County Public Library.[52]

The high-consequence risk from **extreme heat** for the buildings sector is the potential increase in scope and duration of power outages during extreme heat events, which would affect the ability of County facilities to remain open and operational.

In addition, at landfills, extreme heat can increase internal landfill temperature, which increases the risk for landfill fires and explosions and damage to contamination control features (e.g., liners and gas/leachate conveyance systems, pumps). This could result in landfill facility closure, and the lack of sanitary disposal of waste as well as the potential exhaust and fumes present human health risks. This could also result in the escape of leachate and gases into the environment, posing a risk to ecological health and contributing to County emissions.

Winter storms pose a risk to the buildings and facilities sector due to the potential for buildings to be inoperable after extended events and for power outages to disrupt normal operations at facilities. The 2022 HMCAP also states that buildings can be damaged during winter storms when snow loads exceed the design

[52] See the 2022 Frederick County Hazard Mitigation and Climate Adaptation Plan, Appendix A for a complete list of critical facilities likely to be exposed to pluvial flooding.

capacity of their roofs or when trees fall due to excessive ice accumulation on their branches. In heavier, wetter, snows, roof collapse becomes a concern.

4.5.8 People and Health

The people and health sector encompasses the divisions shown in Table 19, with sector-specific high-consequence risks due to climate hazards listed after.

Table 19: County Divisions and Corresponding Asset Classes and Operations in the People and Health Sector

County Division(s)	Asset Classes and Services
Citizens Services	Provision of low or no cost person-centered housing, human services, and community resources
Senior Services	Senior Center
Sheriff's Office	Detention Center
Health	Public Health Department and healthcare services

Future changes in **flooding events, extreme heat, and winter storms** will pose high-consequence risks to populations and public health. The following prioritized risks will all increase the need for adequate County staffing to respond, at the same time the public has increased expectations for government support.

Future increases in the frequency and intensity of **flooding** will impact the County's services, such as delays in services to homebound individuals and for access to the groceries for seniors' program during inclement conditions. Flooding will adversely affect public health, including physical and mental health effects, and in turn affect the demand for the County's public health related services.

Changes in **precipitation patterns** can affect water tables and wells, and in turn public health. Groundwater water supplies in karst areas of the County can be impacted by extreme rainfall events. Furthermore, changes to the water table due to changes in precipitation patterns will affect the seasonal testing for septic system suitability. Additionally, private wells can be flooded, rendering the drinking water unsafe until wells can be pumped out and disinfected. Lastly, power outages due to extreme storm events could disrupt pumping of potable water from private wells, as well as septic system pumps which could affect sewage disposal.

Additionally, the 2022 Hazard Mitigation and Climate Adaptation Plan (HMCAP) identifies that flooding events can lead to a concentration of garbage, debris, and toxic pollutants in water supplies, which can cause health hazards. Drinking water can become contaminated, especially if treatment plants are flooded. This can result in disease and other health problems, especially in underdeveloped areas.

Projected increases in **extreme heat days** will lead to significant public health consequences. Increased intensity of extreme heat events increases risk of heat illness and hospitalization for both the County staff and broader community. For example, County outdoor personnel carrying out public services and operations and maintenance may be at greater risk to heat stress. The impacts of climate change on human health will vary and depend on, among other factors, an individual's sensitivity and exposure to a given threat and capacity to adapt. Greater number of extreme heat days poses an increased health risk for certain demographics who are more at risk to heat, including those who cannot afford access to air conditioning and housing, those over the age of 65, and those reliant on electronic medical devices and refrigerated medication (see the Emergency Management and Response section above for further details). Heat waves will cause increases in heat stress and reduced air and water quality. The 2022 HMCAP identifies that locally, there is also a correlation between heat waves and the occurrence of high ozone days. Generally, the hotter the temperature, the more favorable the

conditions are for ozone-producing chemical reactions in the air, which can lead to an increase in asthma cases and exacerbation of chronic respiratory diseases.

Extreme events including snowstorms could disrupt the County's services to populations and health, including disrupted medical services and delayed emergency response, and delays in services to homebound individuals and for access to the Groceries for Seniors program.

4.5.9 Economy

The economic sector encompasses the divisions shown in Table 20, with sector-specific high-consequence risks due to climate hazards listed after.

Table 20: County Divisions and Corresponding Asset Classes and Operations in the Economy Sector

County Division(s)	Asset Classes and Services
County Executive (grants/economic development) Economic Development Finance	County services related to economic development

All hazards included in this vulnerability and risk assessment have the potential to affect the County's economy.

Flood damage to infrastructure will increase County expenses and potentially insurance premiums. **Extreme heat** could affect outdoor workers' health and productivity due to heat stress or illness, and could reduce agricultural revenue via reduced livestock fertility and milk and egg production. Similarly, **drought** could reduce agricultural revenue via reduced crop yields and plant productivity.

The 2022 Hazard Mitigation and Climate Adaptation Plan (HMCAP) identified economic risks due to **increased temperatures, winter storms, and drought.** As temperatures rise, some crops may experience a decrease in the length of the growing season, resulting in less revenue for the County and its citizens. Winter storms from 1996 to 2021 resulted in $406,988 of property damages and $208,282 in crop damages. Based on historic damages, Frederick County may experience on average $526,027 in winter weather-related costs (road clearing and damages) annually. Additionally, the HMCAP identifies that drought is likely to cause financial related stress for farmers.

4.6 Climate Impacts and Consequences: Other Risks

This section presents the additional risks that the study team and divisions identified but did not deem to be high-consequence. As mentioned in the section above, the study team defined ***high-consequence risks*** as those that could result in severe injury or death; halt normal operations; require replacement of an asset; and/or significantly add costs beyond the division's expected budget. As such, the findings in this section are higher-level than the discussion above on high consequence risks.

4.6.1 Water and Sewer

Table 21: Other Climate Risks and Consequences for the Water and Sewer Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Water and Sewer Utilities	Water and sewer mains	Flooding	Severe stream bed and bank erosion can expose (linear) assets.	Increased maintenance and repair costs. Potential for interruption in service.
	Sewer system	Flooding	Flooding can cause pump stations and treatment plants to break down and untreated sewage to overflow out of the system, resulting in sanitary sewer overflow.	Increased risks to public health. Increased maintenance and repair costs.
	Sewer system	Extreme heat	Increased production of corrosive hydrogen sulfide at WWTP.	Increased maintenance costs.
	Operations	Extreme heat	Division participates in demand response/load shedding during high heat days/when called.	Reduction in service.
	Emergency generator	Winter storms	Winter storms can damage electric components of the power system, leading to power outages and increased DWSU/ generator use.	Interruptions in service. Increased maintenance costs.
	Water sources	Drought	Groundwater may not be adequately replenished during drought years; Use of surface water is restricted if there is not adequate flow.	Limited water availability.

4.6.2 Stormwater

Table 22: Other Climate Risks and Consequences for the Stormwater Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Stormwater (within Energy and Environment)	Planning	Flooding	Insufficient (in terms of quantity and quality) stormwater infrastructure in urbanized and urbanizing neighborhoods.	Increased risk of system capacity being exceeded, which increases risks to public health and safety.
	Stormwater system	Flooding	Road crossings over streams and drainage conveyances could be overtopped. This can wash hazardous materials into the stream, leading to water pollution in commercial and industrial hotspots.	Increased risks to public health and safety and to environmental health.
	Stormwater system	Winter storms	Stormwater pond emergency spillways can add water to the drainage system.	Increased flooding. Disruption to normal drainage.

4.6.3 Emergency Management and Response

Table 23: Other Climate Risks and Consequences for the Emergency Management and Response Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Fire and Rescue Services; Emergency Management	Emergency response	Flooding	Limited ability to reach those in need when roads are flooded.	Increased risk to public safety.
	Fire stations	Winter storms	Disruption of services due to power outages or inability to access roads.	Increased risk to public safety.
	Emergency response	Extreme heat	Increased demand for emergency response as heat-related illness increases.	Increased risk to public safety.

4.6.4 Transportation

Table 24: Other Climate Risks and Consequences for the Transportation Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
TransIT Services	Public transit; Paratransit	Flooding	Difficulty for users to access bus stops safely.	Increased risks to safety.
	Public transit; Paratransit	Heat	Increased wear and tear on vehicles, decreasing the useful life.	Increased costs of maintenance and repair.

Division	Asset Class, Service	Hazard	Risk	Consequences
Public Works	Roads and sidewalks	Heat	Increased temperatures soften pavement.	Decreased safety and reliability. Increased costs of maintenance and repair.
	Roads and sidewalks	Flooding, Winter storms	Road and sidewalk surface damages, erosion, and closures.	Increased costs of maintenance and repair. For example, the County spent $11.7 million on maintenance and repair of roads and utilities after extreme storm events from 2010-2015.
	Bridges	Flooding	Bridge scour and potential washout.	Increased costs of maintenance and repair.
	Bridges	Heat	Expanding bridge joints.	Increased costs of maintenance and repair.
	Bridges	Winter storms	Ice accumulation on bridges.	Increased risk to safety.
	Fleet	Flooding, Winter storms	Increased wear and tear on vehicles. Increased frequency of delays (impassable routes) and difficulty for staff to access vehicles during severe weather.	Increased costs of maintenance and repair. Interruptions in service.
	Fleet	Heat	Increased wear and tear on vehicles, decreasing the useful life.	Increased costs of maintenance and repair.
	Fleet	All	Power outages affecting EV charging stations.	Interruptions in access to/reduced usage of vehicles.
	Operations	Winter storms	Extended crew deployment to plow snow.	Overtime costs.

4.6.5 Natural and Cultural Resources

Table 25: Other Climate Risks and Consequences for the Natural and Cultural Resources Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Parks and Recreation	Parks, nature centers, and picnic centers.	Flooding	Flooding can limit access and damage playground and picnic equipment.	Reduced accessibility to outdoor areas.
	Recreation centers, gyms, and athletic venues	Flooding	Roof leaks and temporary inundation.	Reduced accessibility to recreation centers. Increased maintenance costs.

Division	Asset Class, Service	Hazard	Risk	Consequences
	Recreation centers, gyms, and athletic venues	Flooding	Destruction of building materials and damage to equipment could lead to closures.	Reduced accessibility to recreation centers. Increased maintenance costs.
	Historic sites and grounds	Flooding	Flooding can limit access and damage historic artifacts (depending on the type).	Reduced accessibility to historic areas
	Parks, nature centers, picnic centers, recreation centers, gyms, and athletic venues	Extreme heat	Increased incidence of high-heat index days and need for air conditioning.	Increased cost for air conditioning in facilities; Decreased demand for outdoor recreation during high heat days.
	Parks, nature centers, picnic centers, recreation centers, gyms, and athletic venues	Extreme heat	High temperatures can lead to heat stress for those participating in outdoor activities.	Increased risk of public health hazards due to extreme heat. Decreased demand for outdoor recreation during high heat days.
	Parks, nature centers, and picnic centers	Extreme heat	Increased evapotranspiration decreases water in soil, leading to wilting of vegetation and potential tree/plant death in the face of extreme heat.	Increased maintenance costs.
	County trees	Extreme heat	Increased tree diseases and pests combined with globalization means threats to forests, need to plant different species, more costs to manage.	Increased maintenance costs.
	Parks, nature centers, and picnic centers Historical sites and grounds	Winter storms	High winds and heavy snow can topple trees.	Increased risks to safety. Increased costs for park maintenance.
	Parks, nature centers, and picnic centers	Winter storms	Heavy snow can damage landscape shrubs and plants.	Increased maintenance costs.

Division	Asset Class, Service	Hazard	Risk	Consequences
	Parks, nature centers, and picnic centers	Drought	Drought stresses plants and can make them more susceptible to damaging pests. Trees need maintenance water during drought.	Increased costs for park upkeep and maintenance.
Economic Development	Crops	Extreme heat	Longer growing season, change in crop plans and varieties planted.	Increased maintenance costs.
	Agricultural land	Drought	Drought causes water stress to crops. Increases susceptibility to destructive pests.	Decreased yield. Increased costs.
Energy and Environment (Stormwater Department)	Watershed and ecosystem	Flooding	Runoff of chemicals into the streams.	Threats to the environment. Water quality may not comply with standards.
	Watershed and ecosystem	Flooding	Increased damage to streams including bank erosion, biological impairment, more pollutants attached to sediment.	Threats to the environment. Increased costs of watershed restoration.
	Watershed and ecosystem	Winter storms	Road salt runoff changes conductivity in receiving streams.	Threats to the environment. Water quality may not comply with standards.
	Watershed and ecosystem	Drought	Severe drought could impact streams and could dry up/kill all water obligatory species.	Threats to the environment and ecosystem.

4.6.6 Information and Communication Technology

Table 26: Other Climate Risks and Consequences for the Information and Communications Technology Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Interagency Information Technologies	Data center	Flooding	Higher risk of flooding low-lying and underground infrastructure, which could lead to flood damage and outages.	Increased costs of maintenance and repair; Increased frequency of power outages.
	Data center	Extreme Heat	Increased temperatures burden cooling equipment.	Increased costs of maintenance and repair. Increased frequency of power outages.

Division	Asset Class, Service	Hazard	Risk	Consequences
	Services	Winter storms	Increased frequency of high winds that topple power lines and cause outages.	Increased costs of maintenance and repair. Increased frequency of power outages.
	Services	Winter Storms	Increased frequency of high winds that topple power lines and cause outages.	Increased costs of maintenance and repair. Increased frequency of power outages.

4.6.7 Buildings and Facilities

Table 27: Other Climate Risks and Consequences for the Buildings and Facilities Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Public Works	Planning and design	Flooding	Increased property size to accommodate stormwater management facilities.	Increased costs.
	Operations	Flooding	Difficulty in getting to County facilities during storm events.	Increased risks to safety; Interruption in operations.
	Parking lots	Flooding	Flooding in parking lots.	Increased risks to safety; Interruption in operations.
	Planning and design	Flooding, Extreme Heat	Changes to building envelope design.	Increased costs.
	County facilities	Extreme heat	Increased cooling degree days and extreme heat days increase energy use, especially for older buildings. Greater stress on HVAC systems, need to appropriately size. Increased electricity demand charges from building cooling.	Increased costs (cooling energy and facilities maintenance); Potential impacts to HVAC sizing criteria.
	County facilities	Extreme heat	Risk of localized brownouts from intense AC demand.	Increased risks to safety.
	County facilities	Extreme heat	Greater heat absorption from roofs, costs to convert to TPO/light roofs	Increased costs.
	County facilities	Winter storms	Inclement weather and snowy/icy roads can result	Interruptions in normal operations.

Division	Asset Class, Service	Hazard	Risk	Consequences
			in temporary government closure.	
	County facilities	Winter storms	Potential for roof collapse and other snow- or ice-based damage.	Human safety hazard. Increased maintenance and repair costs.
	Utilities	Winter Storms	Increased need to repair damages to utilities after storm events.	Widespread/intense events may stress employee capacity and pose safety risks to employees.
	County facilities	Winter storms	Increased damage to building masonry and metal components due to salt damage.	Increased maintenance and repair costs.
	County facilities	Winter storms	Greater costs for snow and ice removal on County facilities for County Highway Operations.	Increased costs.
	County facilities	Winter storms	Some County buildings are served by well and septic systems; these could be affected.	Increased risk to public health.
Solid Waste and Recycling	Landfill	Extreme heat (atmospheric heat)	Causes conditions unsuitable for operation of landfills such as inability for humans to work and equipment to function properly.	Sanitary disposal of waste ceases; Increased risk to public health.

4.6.8 People and Health

Table 28: Other Climate Risks and Consequences for the People and Health Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
Citizens Services	Services	Flooding	Increased incidence of flooded homes. Lack of supply of temporary housing	Vulnerable communities are exposed to flooding. Increased expenses of flood insurance decrease housing affordability
	Services	Extreme heat	Increase in urban heat island effect, making the current built environment less comfortable. Increased need for reinforcement of livability code in rental units for property	Risks to public health. Equity impacts.

Division	Asset Class, Service	Hazard	Risk	Consequences
			owners to repair mechanical systems.	
Sheriff's Office	Services	Flooding	Roadway closures can prevent vehicle travel.	Risks to public safety.
	Detention center	Flooding	Potential for water damage to building and contents, including inmates' living quarters and personal belongings.	Risks to public health. Increased costs for maintenance and repairs.
	Detention center	Extreme heat	Increased cooling degree days and extreme heat days increase energy use, especially for older buildings.	Increased cooling costs.
	Detention center	Extreme heat	Increased exposure of inmates and staff (with little control over their environment) to extreme heat.	Risks to public health.
	Detention center	Winter storms	Increased exposure of inmates and staff (with little control over their environment) to extreme cold.	Risks to public health.
Health	Public Health Department	Flooding	Increased damage to property. Decreased access to services.	Risks to public health. Increased repair costs.
	Public Health Department	Flooding	Public health response needs given public sewer overflows.	Risks to public health.
	Public health	Flooding	Increased risk of exposure to waterborne pollutants.	Risks to public health.
	Public health	Flooding	A warmer climate could increase prevalence of mosquitos and result in increased cases of vector-borne diseases, such as the West Nile Virus, Zika, or malaria.	Risks to public health.
	Public health	Heat	Increased strain on low-income communities who may not be able to afford air conditioning.	Risks to public health. Equity impacts.
	Public health	Drought	Increased dust causes allergies, asthma, and other respiratory illnesses. Low-income communities suffer disproportionate mental and physical health impacts.	Risks to public health. Equity impacts.

Division	Asset Class, Service	Hazard	Risk	Consequences
	Public health	All	Power outages leading to negative health impacts, including loss of perishable foods/medicine, exposure to extreme temperatures, and increased risk for injury in the dark.	Risks to public health.

4.6.9 Economy

Table 29: Other Climate Risks and Consequences for the Economy Sector

Division	Asset Class, Service	Hazard	Risk	Consequences
County Executive	County Executive projects	All hazards	Climate hazards can derail and/or delay County Executive projects.	Need to expand the Fiscal Year budget to accommodate climate impacts.
Economic Development	Revenue generators, housing, and infrastructure	Flooding	Flooding events can cause damages to crops, housing, and infrastructure.	Loss of revenue (from 1993 to 2015 resulted in $60,320 in crop damages). Increased grants/loans to small businesses.
	Agricultural land	Flooding	Flooding events damage soil health and crops.	Reduced revenue.
	Crops	Extreme heat	Potential for increased pest activity.	Reduced revenue.
	Crops	Extreme heat	Reduced pollination and plant yield (initially increased yield to commodity crops with later decrease).	Reduced revenue.
	Livestock	Extreme heat	Heat stress affects reproductive efficiency and can cause physiological changes. Heat stress negatively affects the appetite, lactation yield, and rumen fermentation of dairy cows.	Reduced revenue.
	Livestock	Drought	Less feed available for livestock can cause death and reduced fertility.	Reduced revenue.

Division	Asset Class, Service	Hazard	Risk	Consequences
	Agricultural land	Winter storms	Extreme cold and temperature variations can kill vegetation. Strong winds can collapse or damage farming facilities.	Reduced revenue.
	Livestock	Winter storms	Animal loss: young animals are more susceptible to extreme cold; chicken eggs can freeze; animals can go missing or be injured during storm. Losses in fodder yield due to winter kill.	Reduced revenue.
	Planning	Winter storms	Threat to loss of local and regional attractiveness to employers and labor force due to extreme weather.	Reduced revenue.

5 Resilience Strategies for Climate Risks

5.1 Introduction

As described in the Climate Risk and Vulnerability Assessment chapter, Frederick County is currently experiencing and will continue to experience changes in climate in the coming years. Among these changes are likely increases in the duration and frequency of heat waves and intensified flooding from extreme precipitation events. To cope with such climate events, this chapter identifies and describes actions the County can take to mitigate climate change impacts and incorporate climate resilience into operations, policies, and infrastructure planning and maintenance.

Climate resilience is the ability to prepare for, recover from, and adapt to climate risks.[53] A related concept, **climate change adaptation**, refers to those actions taken to prepare for and adjust to actual or expected climate changes, thereby mitigating harm, building resilience, and/or taking advantage of new opportunities.[54]

Climate change adaptation actions and strategies that build climate resilience can include measures that avoid risks, prepare for, or mitigate the negative impacts of risks, or transfer risks to another party (via insurance or other mechanisms). In practice, this can include efforts to improve capacity to monitor and understand climate risks, ensure plans and policies utilize forward-looking climate projections, and physical upgrades to buildings and infrastructure. The study team identified **14 overarching resilience strategies** to address key risks and vulnerabilities (Table 30), each with its own subset of specific adaptation actions. The strategies in this section build upon existing risk mitigation efforts and address gaps in policies and plans to identify areas where the County can act to further strengthen climate resilience.

Note that the Division of Energy and Environment (DEE) referenced frequently in this chapter was previously the Office of Sustainability and Environmental Resources (OSER).

Table 30: Summary of Climate Resilience Strategies

Hazard	Proposed Strategy
Multi-Hazard	• Ensure resilience efforts are equitable and support environmental justice • Assess and update codes and ordinances to be climate risk informed • Ensure emergency management and event response plans are climate risk informed • Advance monitoring and awareness of green infrastructure and nature-based solutions that meet County climate and operational goals • Build in resilience considerations into budgeting and capital improvement processes • Develop and adopt indicators and inter-division collaboration mechanisms to monitor and adaptively manage climate resilience measures over time • Install generators/backup power at critical facilities

[53] Center for Climate and Energy Solutions. 2019. "What is Climate Resilience and Why Does it Matter?" Available at: https://www.c2es.org/wp-content/uploads/2019/04/what-is-climate-resilience.pdf.

[54] U.S. Global Change Research Program. 2014. "Chapter 28: Adaptation. Climate Change Impacts in the United States: The Third National Climate Assessment." Available at: https://nca2018.globalchange.gov/chapter/28/.

Flooding	• Develop deeper understanding of flood vulnerabilities • Build overall resilience to stormwater flooding • Prevent flood-related interruptions to County services and/or use of County assets • Increase resilience of County infrastructure to flood-related damage • Understand and reduce risk of water contamination
Heat	• Protect human health from extreme heat • Increase resilience of County infrastructure to extreme heat

Adapting to climate change and building resilience will be an ongoing process. Additional work will be needed to refine and implement these resilience strategies, including conducting more community outreach and further taking into account important considerations such as equity and evolving regional and State policies. Developing division-specific strategies will also require significant input from and across divisions to ensure a collaborative vision of a resilient future.

5.1.1 Context

The County has taken steps to integrate climate resilience into planning processes, programs, and projects in the updated Hazard Mitigation and Climate Adaptation Plan and has passed initiatives to establish a comprehensive program to address climate change. The proposed actions set forth by the HMCAP and Climate Emergency Mobilization Workgroup (CEMWG) align with those in the Metropolitan Washington 2030 Climate and Energy Action Plan (CEAP), which identified priority collaborative actions to help the region become more resilient. These include capacity building and training on climate resilience, developing a set of regional climate projections and design standards, and supporting local climate planning efforts.[55] The regional CEAP serves as the basis for the County's efforts.[56]

Addressing climate risks and building resilience help the County save operational and maintenance costs incurred by impacts from climate change and better serve constituents by maintaining access to critical services during disaster events. In addition, addressing climate risk can benefit the County's ability to finance capital improvements over time. Bond credit rating agencies now consider climate change as part of their evaluation of credit for local governments, taking into consideration the potential impacts of climate change on the financial health of the local governments and the local government's ability to repay. The presence of climate risks could negatively impact the County's rating and increase the cost of borrowing/interest rates if such issues are not addressed. On the flip side, **climate adaptation and resilience efforts can help ensure that a local government maintains strong credit ratings.**

In addition to fiscal benefits, taking action to adapt to climate change and build resilience can have co-benefits that help the County achieve goals in other areas. For example, increasing plantings and implementing green infrastructure such as bioswales to manage stormwater associated with increased precipitation in the future can improve air quality and reduce heat on high-heat days.

The following strategies and associated actions are recommendations to further enhance the resilience of the County under a changing climate, taking into account the climate risk and vulnerability assessment in the

[55] Metropolitan Washington Council of Governments. 2020. "Metropolitan Washington 2030 Climate and Energy Action Plan." Available at: https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/.

[56] Moore, Shannon. 2020. Baseline, Goals, Regional Coordination, and Frederick County Plans and Actions to Date. Frederick County Office of Sustainability and Environmental Resources. Available at: https://frederickcountymd.gov/DocumentCenter/View/326825/ClimateChange-WF.

previous chapter and building on the strategies from the HMCAP, the CEMWG Climate Response and Resilience Plan, and MWCOG's Climate and Energy Action Plan.

5.1.2 Methods

The study team considered multiple climate hazards that could affect Frederick County: extreme heat, flooding, winter storms, and drought. While all four of these hazards are associated with high-consequence climate risks for the County based on the findings of the Chapter 4: Climate Risk and Vulnerability Assessment and stakeholder input, the study team decided to focus on developing resilience solutions for flooding and heat. This decision was based on the wide-ranging impacts of flooding and heat across FCG departments and sectors, and the strong likelihood that these hazards will worsen with climate change. For example, more frequent and intense flooding can disrupt traffic and County services, damage infrastructure, and convey contaminants into waterways. Higher temperatures can contribute to droughts and restrictions on water supply, increase the likelihood of power outages during heat events, and elevate the need for emergency response to heat-related incidents. **Building resilience now will ensure Frederick County continues to thrive as these risks become more severe.**

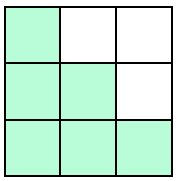
A broad list of resilience strategies was identified based on the County's previous resilience work, stakeholder input from County divisions, and the findings of the climate risk and vulnerability assessment. The list was refined using the 2022 HMCAP to ensure continuity with existing climate resilience efforts. Discussions with County divisions further refined remaining strategies and identified gaps. ICF climate resilience experts finalized the list of actions and organized it into a set of broad, overarching strategies. ICF worked closely with County staff to capture implementation detail that identify focal divisions, timelines, and costs for each proposed action.

5.2 Proposed Strategies

The following resilience strategies will help Frederick County address priority risks associated with climate change and build resilience in County operations. Because climate resilience is closely linked with other County development priorities, these strategies prioritize coordination and integration with existing plans, processes, and programs and identify ways to work across divisions. Further, the strategies identify links with the 2022 HMCAP as well as with the climate mitigation actions proposed in Chapter 3: Climate Mitigation Scenario Analysis and Strategies of this CEAP.

Each strategy includes a cohort of actions that are described in tables on the following pages. Each action includes information on lead implementer, timeline, costs, beneficiary groups and assets, and links with HMCAP and mitigation actions outlined, as defined in Table 31.

Table 31: Implementation Details Provided for each Adaptation Action

Lead Implementer	Denotes County divisions that may be involved in implementing and/or managing the action.
Timeline	Approximate timeline for action implementation. This is defined as:  Short term: within one year Medium term: 1-5 years (within current planning and budgeting cycle) Long term: >5 years (beyond current planning cycle)
Costs	Approximate relative costs for investment in each action. The symbology is defined as follows: • No symbol: Staff time only. • $: Minimal to no additional investment required. E.g., desk research, outreach, surveys, meetings, and processes that integrate with or take advantage of existing programs. • $$: Small-scale additional investment required. E.g., small construction or additional operations or maintenance programs. • $$$: Medium- to large-scale additional investment required. E.g., large-scale investment in road updates, construction, or retrofits. Note: These estimates are not based on full costing and are provided for purposes of prioritization only.
Beneficiary Groups and Assets	Denotes entities that will benefit from the action – both indirectly and directly. This is indicative. Asset groups (e.g., roads) that will be involved in and benefit from the action.
Links with HMCAP and Mitigation Actions	Denotes where an action contributes to the strategies outlined in the HMCAP, either directly or indirectly, and/or where an action has a climate mitigation co-benefit that links with the actions from the mitigation chapter of the CEAP.

5.2.1 Multi-hazard

Strategy 1: Ensure resilience efforts are equitable and support environmental justice

Existing policies, plans, and programs:

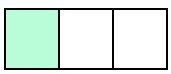
Existing community outreach

Frederick County Equity and Inclusion Commission

As discussed in the Climate Risk and Vulnerability Assessment chapter, certain populations face greater vulnerability to the impacts of climate change due to their socioeconomic characteristics. Vulnerable populations can include low income, minority, marginalized groups, youth, the elderly, and disabled persons. To combat this inequity, recent efforts – including the HMCAP and MWCOG 2030 Climate and Energy Action Plan (CEAP) - have identified several ways to ensure that climate hazards are addressed in vulnerable communities and that these communities benefit from implementing resilience strategies. Strategy 1 aligns closely with Objective 4 from the 2022 HMCAP, which aims to prioritize equity and vulnerable populations in the implementation of hazard mitigation projects. In addition, this strategy builds upon the MWCOG CEAP, which emphasizes incorporating equity principles in resiliency solutions.

The MWCOG CEAP identifies Equity Emphasis Areas that can be used as a starting point to identify potentially vulnerable populations. The County can build on the methods in the MWCOG CEAP to identify vulnerable neighborhoods and meet with community leaders and members to understand how to build resilience strategies that will provide maximum support. Implementing this strategy will help ensure that resilience measures implemented by the County are done so equitably, aim to directly support the populations most in need of resilience, and include a seat at the table to involve these communities in the decision-making process via their input and buy-in.

Action 1A: Identify vulnerable neighborhoods

Description: Conduct a study to identify the vulnerable neighborhoods that are the least climate hazard-resilient and prioritize them for resilience investments.	**Lead Implementer(s):** Planning Citizen Services Division of Energy and Environment
Timeline: 	**Costs:** Staff time
Links with HMCAP and Mitigation Actions: • Aligns with HMCAP Objective 4; HMCAP Action FC-3**8; and HMCAP Action FC-26**	**Beneficiary Groups and Asset Groups:** • Public • Vulnerable communities

Action 1B: Engage vulnerable communities in climate resilience

Description: Identify community leaders and organizations within identified vulnerable neighborhoods. Establish lines of communication to collect targeted community input and help meet community needs as part of development and implementation of climate resilience strategies for County operations.	**Lead Implementer(s):** Planning Citizen Services

Timeline:	**Costs:**
– 	Staff time
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• Aligns with HMCAP **Action** FC-40	• Public • Vulnerable communities

Strategy 2: Assess and update codes and ordinances to be climate risk informed

Existing County policies, plans, and programs:

Existing codes, ordinances, permits, and plans (TBD based on proposed assessments)

Updating relevant County policies, plans, and codes using forward-looking climate projections will help enable new development and retrofits to be resilient to projected climate impacts. This action draws on the MWCOG CEAP, which directs member jurisdictions to mainstream climate considerations into the overall planning process, and the 2022 HMCAP, which aims to increase the number of policies and ordinances that consider future conditions. The climate risk analysis presented in Chapter 4 can be applied to all government plans, including zoning, building codes, ordinances, and the development review process. Designing projects to account for climate change can reduce economic damages, as building or retrofitting to account for future climate risks is more cost effective than rebuilding or repairing buildings and infrastructure after an extreme weather event.

Several federal programs incentivize integration of resilience practices into codes and ordinances. These include the FEMA Community Rating System (CRS), a voluntary incentive program that provides discounted flood insurance premium rates to communities that take flood prevention actions that exceed the minimum requirements of the National Flood Insurance Program (NFIP).[57] The County has taken the initial steps to prepare to apply to CRS as part of the 2022 update to the Hazard Mitigation Plan. This includes reviewing elements of the floodplain ordinance that would receive CRS credit and working to resolve zoning issues that need to be completed before enrollment in the program can begin. To apply, the County will appoint a coordinator to serve as a liaison between FEMA and the community. The coordinator submits a letter of interest to the FEMA Regional Office with documentation of floodplain management activities.

In addition to the NFIP alignment, for codes and ordinances related to flooding, the Maryland Department of the Environment (MDE)'s Advancing Stormwater Resiliency in Maryland (A-StoRM) effort will result in new regulations targeting development and redevelopment processes and approvals. These include increasing the required minimum Environmental Site Design (ESD) stormwater volume by 10% from managing 2.7 inches of rainfall to managing 3 inches of rainfall. Along with the managed volume increase, the design storm precipitation standards may change from the current TP-40 data set to the 2004 NOAA Atlas 14 data set and its successive iterations. The NOAA Atlas data set is a more robust data set allowing for finer calculation of increased intensities and frequencies as well as duration of storm events. This will allow for more accurate prediction of future events and implementation of resiliency strategies in responses. The County is participating

[57] FEMA. 2018. National Flood Insurance Program Community Rating System. Available at: https://www.fema.gov/floodplain-management/community-rating-system.

in this process and plans to assess and modify its own codes and ordinances to meet or exceed the stringency of those set by MDE and review any grandfathering clauses. This will be a three-year process.[58]

Beyond these efforts, the Building Code Effectiveness Grading Schedule (BCEGS) program encourages the implementation and enforcement of building codes that minimize losses from natural hazards. Municipalities (including counties and cities) within a state are assessed and graded based on the administration of building codes, plan review, and field inspection, with an emphasis on reducing risk from natural hazards. BCEGS grades are assigned on a scale of 10 to 1, with 1 corresponding to exemplary building code enforcement. After the grades are assigned, they are translated into insurance credits.[59] The County has been assessed for BCEGS and assigned a score of 4, which is average for the state.[60] One way the County can further improve their BCEGS rating is by holding structures to higher building standards that mitigate potential hazards. The County's Planning and Permitting department can work with contractors and customers to go above and beyond BCEGS standards, as was done in Washington County, Maryland.[61] Implementation of CRS and BCEGS bolsters community resilience to natural hazards and creates cost savings from insurance rate reductions for citizens and businesses.

Action 2A: Update codes and ordinances	
Description: Work across divisions to evaluate relevant codes and ordinances to identify opportunities for addressing issues related to hazard mitigation and climate resilience. Examine both historical climate events as well as projected climate change conditions to find ways to improve and enhance County codes and ordinances to reduce climate risk. Opportunities may include requirements for assets to bolster resilience to power outages, extreme heat, and stormwater flooding. Update codes and ordinances based on these findings. See Strategies 8, 11 and 14 for more specific recommendations for building County asset resilience to flooding (8 and 11) and heat (14).	**Lead Implementer(s):** Planning Public Works
Timeline: 	**Costs:** $
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:** • Public

[58] Maryland Department of the Environment. "Advancing Stormwater Resiliency in Maryland (A-STORM)." Available at: SB227 (maryland.gov)

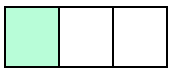
[59] Insurance Service Office. Building Code Effectiveness Grading Schedule (BCEGS®). Accessed May 13, 2022. Available at: https://www.isomitigation.com/bcegs/

[60] Verisk. "Facts and Figures about BCEGS Grades around the Country." https://www.isomitigation.com/bcegs/facts-and-figures/

[61] Thomure, Dale. 2016. BCEGS® Spotlight: Washington County, Maryland. Accessed July 4, 2022. https://www.isomitigation.com/newsletter/fall-2016/bcegs-spotlight-washington-County-maryland/

• Aligns with HMCAP FC-4, Objective 7 and Objective 13	• County divisions, including Energy and Environment, Emergency Management • Public Works • Economic Development • Various asset groups

Action 2B: Conduct Community Rating System (CRS) activities

Description: Obtain the Building Code Effectiveness Grading Schedule (BCEGS) building code evaluation to support CRS activities in the County. The County can also help smaller municipalities bolster BCEGS grades by incorporating climate projections into building standards and design codes. The County's planning and permitting department can work with contractors and customers to ensure buildings meet or exceed BCEGS qualifications.	**Lead Implementer(s):** Emergency Management Planning and Permitting Public Works
Timeline: 	**Costs:** Staff time
Links with HMCAP and Mitigation Actions: • Aligns with **HMCAP Action FC-2; Objective 7; and Objective 13**	**Beneficiary Groups and Asset Groups:** • Public • County divisions, including Public Works, Risk Management, and Economic Development • County Facilities

Strategy 3: Ensure emergency management and event response plans are climate risk informed

Existing County policies, plans, and programs:

AlertFC, Frederick County Government's emergency notification system

READY Frederick County

Division Continuity of Operations Plans

Frederick County Evacuation Plan

Incorporating climate risk parameters into emergency management and event response plans can help bolster the ability of the County to respond to and recover from future floods, storms, and extreme heat events. This strategy aligns closely with Objective 8 of the 2022 HMCAP, which aims to ensure County residents can safely evacuate or shelter during a hazard or emergency, and the MWCOG CEAP, which directs member jurisdictions to mainstream climate risks into all government plans, including emergency management plans. Integrating climate risks will help identify areas likely to be heavily impacted by frequently flooded roads, or communities vulnerable to extreme heat, that can be factored into the County's updated emergency management plan and continuity of operations plans (COOP). In addition to updating emergency plans and policies, emergency vehicles should also be weatherized to function during extreme winter storms and frequent heat waves.

Action 3A: Integrate climate vulnerabilities into evacuation plan update

Description: Coordinate with the proposed update to Frederick County's evacuation plan (per the HMCAP). Bolster resilience of the evacuation plan by p**lanning for** potential transportation climate vulnerabilities (e.g., frequently flooded routes). Increase equity by ensuring evacuation routes are accessible to vulnerable communities. Consider whether resilience hubs could be integrated into locations with microgrids or other emergency staging sites.

Lead Implementer(s):

Emergency Management

Public Works

Timeline:

Costs:

$-$$

Links with HMCAP and Mitigation Actions:

- **Aligns** with **HMCAP Action FC-9; Objective 8**

Beneficiary Groups and Asset Groups:

- Public
- County divisions including Emergency Management, Fire and Rescue Services

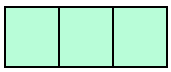
Action 3B: Update division emergency response policies to align with resilience plans

Description: Update existing division- specific emergency response policies and COOPs to align with new/updated FCG-wide flood operational plan and County heat stress policy (see actions 10A and 13B, respectively) where applicable. For divisions that do not have existing operational flooding/heat/extreme event policies, conduct trainings to integrate new policies into their operations and management.

Lead Implementer(s):

All divisions

Timeline:



Costs:

Staff time, potentially $ for consultant time

Links with HMCAP and Mitigation Actions:

- N/A

Beneficiary Groups and Asset Groups:

- Various County divisions

Action 3C: Ensure emergency fleet can respond during extreme weather events

Description: Ensure public safety fleet is capable of mobility required during weather extremes via updates to emergency response planning and upgrading vehicles to be more resilient during routine replacement cycles. This includes ensuring fleet vehicles can operate during high heat events, flooding, and extreme winter storms. As a complementary measure, Action 10B aims to ensure

Lead Implementer(s):

Emergency Management

Fire and Rescue Services

Sheriff

there are passable routes in the case of an extreme weather event by repairing roadways and bridges known to experience flooding.	
Timeline: 	**Costs:** $$ (Upgrades to fleet vehicles, if needed)
Links with HMCAP and Mitigation Actions: • **N/A**	**Beneficiary Groups and Asset Groups:** • County divisions including Emergency Management • Sheriff's Office • Fire and Rescue Services • Emergency vehicles • Fire stations

Strategy 4: Advance monitoring and awareness of green infrastructure and nature-based solutions that meet County climate and operational goals

Existing County policies, plans, and programs:

Livable Frederick Development Framework – Green infrastructure sector

Frederick County Complete Streets Manual

Watershed Assessments and Feasibility Studies

Frederick County Tree Solutions Now Act

Nature-based solutions (NBS) weave natural features or processes into the built environment to reduce flood risk, mitigate heat, and improve water quality.[62] Green infrastructure can range in scale from utilizing plantings to manage the stormwater flow for one building to protecting large natural spaces, wetlands, and riparian areas. Green infrastructure can address stormwater volume via storage, infiltration into the ground, or evapotranspiration, and reduces flows to sewer systems or surface waters.[63] In the form of connected network of waterways, wetlands, and other important natural areas, green infrastructure can protect biodiversity, expand green corridors, buffer the impacts of development on the environment, and provide public benefits. Green infrastructure in the form of trees and other plantings exerts a cooling effect on the surrounding area and can reduce local heat extremes.

Recommendations and opportunities to enhance green infrastructure are prevalent in the region. The Maryland Conservation Finance Act, passed in January 2022, expands opportunities for agencies to obtain private investment and financing for green infrastructure projects, among others.[64] The Maryland Department of Natural Resources houses the Green Infrastructure Resilience Program, which provides funding to help local governments evaluate and address stormwater and riparian flooding risks.[65] Projects are approved through Maryland's Chesapeake and Coastal Grants Gateway. Frederick County's Climate Emergency Mobilization Work Group recommends continuing the County's pace of increasing green infrastructure through regenerative

[62] Federal Emergency Management Agency (FEMA). "Nature-based Solutions." Accessed on May 12, 2022. Available at: https://www.fema.gov/emergency-managers/risk-management/nature-based-solutions.
[63] U.S. Environmental Protection Agency. "What is Green Infrastructure?". Accessed on May 12, 2022. https://www.epa.gov/green-infrastructure/what-green-infrastructure.
[64] Maryland Department of Legislative Services. 2022. Senate Bill 348: Conservation Finance Act. Available at: https://mgaleg.maryland.gov/mgawebsite/Legislation/Details/sb0348?ys=2022RS.
[65] Maryland Department of Natural Resources. "Green infrastructure Resilience". Accessed on May 16, 2022. Available at: https://dnr.maryland.gov/ccs/Pages/GIR.aspx.

landscaping, tree planting, and expanding riparian buffers. The County has robust reforestation program which requires permanent perpetual easements placed on reforested lands to ensure long-term protection of these crucial green infrastructure practices. The County's HMCAP promotes the use of green roofs and other types of green infrastructure to reduce the urban heat island effect, and the MWCOG CEAP recommends enhancing green infrastructure networks. Frederick County's Livable Frederick Master Plan outlines initiatives to support to preservation and development of green spaces and contains a map of green infrastructure in the County.

However, the HMCAP recognized not all green infrastructure solutions are feasible or prudent in every context throughout the County and decision matrices will need to be developed to assist in choosing the appropriate climate resilient practice. Opportunities where green infrastructure practices may not be the right fit could include structural integrity of existing roofs for green roofs, site constraints for multiple small-scale practices due to existing underground utilities, requirement to capture the 100-year storm event due to existing flooding concerns downhill from the site, etc. Action 4A highlights the importance of utilizing studies developed through the scientific research funded by the Chesapeake Bay Trust Funds' pooled monitoring. Cutting edge research is continually being developed and written to assist stakeholders in ensuring practices, such as green infrastructure, are utilized in the best locations to assist in assisting with climate resiliency. In 2022, research suggested the use of a combination of green and grey infrastructure may be necessary to capture both quality and quantity stormwater runoff. The County is activity engaged in further understanding the monitoring research to ensure future climate-related benefits through stormwater quality, quantity, and other heat-related concerns are being addressed while considering long-term maintenance costs.

Helping to evaluate research and expand feasible options using nature-based solutions for stormwater and heat management (and associated co-benefits) can have benefits for the County. Decision matrices may assist the County in determining which climate resilient practice and their associated long-term maintenance may be best for each site. Action 4B aims to elevate these nature-based opportunities and encourage developers and property owners to implement green infrastructure in the County. Both new stormwater management structures as well as retrofits can take advantage of natural and green infrastructure. However, in certain circumstances, the conjunction between grey and green infrastructure will yield the best solution to combat certain climate change effects. The County optimizes the use of green infrastructure to a site, considering storage volume, pollution filtration, temperature reduction, site constraints, cost, and other parameters.

Action 4A: Implement green infrastructure monitoring	
Description: Implement monitoring of green infrastructure for stormwater and heat resilience in Frederick County owned and managed facilities, buildings, and transportation assets. Track projects that have climate mitigation and other co-benefits in addition to stormwater runoff volume alleviation (such as reducing carbon footprint, providing shade, reducing heat from roof surfaces, reducing thermal impacts of stormwater, and contributing to improved air quality). Continue to refine a list of priority green infrastructure solutions for application in the County, in coordination with the **Complete Streets Manual** that Planning and Permitting is developing. Evaluate and coordinate with Chesapeake Bay Trust Fund program's pooled	**Lead Implementer(s):** Public Works Energy and Environment Transportation Planning and Permitting *Coordinate with MDE, which "may propose an increase in the implementation of "green infrastructure" … for the 1-year rainfall event" as part of the A-StoRM process.*

monitoring to incorporate climate related stormwater management studies when designing County facilities.

Timeline:

Costs:

$

Links with HMCAP and Mitigation Actions:

- **Aligns** with Aligns with HMCAP Actions FC-3; FC-6.
- Aligns with CEAP Mitigation Strategy 3: Green Building Standards

Beneficiary Groups and Asset Groups:

- Public
- Property owners
- County divisions, including Energy and Environment
- Public works

Action 4B: Conduct green infrastructure and nature-based solutions (NBS) awareness campaign

Description: Conduct an awareness campaign to make sure developers and other relevant parties are aware of incorporating green infrastructure and nature-based solutions, grey infrastructure, and various combinations required to assist in stormwater quality and quantity and heat control practices. Provide outreach events to the public displaying various climate resilient projects the County has implemented on their facilities with regards to relevant stormwater, heat, and carbon mitigation benefits. Specifically focus on options for reducing thermal and pollution impacts on streams, expanding tree canopy, and increasing quality and reducing volume of stormwater and coordinate with the County's Complete Streets program.

Lead Implementer(s):

Energy and Environment

Planning and Permitting

Timeline:

Costs:

$

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-18

Beneficiary Groups and Asset Groups:

- Property owners
- County divisions, including Energy and Environment

Strategy 5: Build resilience considerations into budgeting and capital improvement processes

Existing County policies, plans, and programs:

Capital Improvement Projects

County ESG Reporting Requirements

Division-level CIPs

Successful implementation of resilience actions requires two elements: planning and funding. Factoring resilience considerations into budgeting and capital improvement processes will help ensure these actions are economically viable and provides a roadmap for funding. The Climate Emergency Mobilization Work Group recommends all policy and economic development actions be implemented through the lens of climate change. This helps decision makers think through the long-term costs of investments and will lead them to invest in climate friendly projects and practices.

In Frederick County, the budgeting process is divided into two components: Operating and Capital. The **Operating** budget is determined by the previous year's expenses plus departmental appeals for additional funding that are then reviewed and decided by the County Executive and approved by the County Council. Appeals are evaluated partly on their Division Strategic Alignment, the Livable Frederick Master Plan, and the County Executive's Strategic Priorities. Climate Resiliency is in the Livable Frederick Master Plan in the Environment Section. This includes the Land Category, which incorporates built environment, green infrastructure, agriculture, and tree canopy goals; the Water Category that includes initiatives for stormwater, wetlands, water and sewer adequacy, and thermal impacts to brook trout protections; and the Climate and Energy Category that includes climate resiliency and clean energy goals. The County Executive's Strategic Priorities do not explicitly call out these goals; however, the County Executive's Climate and Energy Initiatives published in December 2021 do and are implicit to her goals. The County Executive's strategic priorities vary depending on who is elected. Divisions can look for existing operating budget items that could feasibly include climate resilience (such as DPW's severe weather contingency line item within its operations budget).

More explicit priorities for integrating resilience into the County budget fall largely within the capital process, which is approved by a committee after reviewing potential projects against pre-determined criteria. In summer 2022, the draft CIP budget decision matrix was updated by the Chief Financial Officer to include Climate Adaptation and Resilience as a standalone criterion. This new criterion assesses how the project will help further and address County goals for the Hazard Mitigation and Climate Adaptation Plan (HMCAP) and this Climate and Energy Action Plan (CEAP), including mitigating risks and keeping up with future climate impacts. This will help to address material disclosures in the County's Environmental, Social and Governance (ESG) reporting requirement for the County's bond ratings. The next step in developing this new criterion is developing a screening process.

Additionally, Frederick County operates multiple Capital Improvement Programs (CIPs) across different Divisions. For example, the Division of Energy and Environment's Department of Stormwater implements a Capital Improvement Program for projects that help the County meet National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements. This CIP program has received several grants from the Maryland Chesapeake and Atlantic Coastal Bays Trust Fund to implement cost-effective capital improvement projects that included stormwater pond retrofits and a creek reforestation program. DEE's Department of Climate and Energy has a CIP for building resilience that includes microgrids. The Frederick County Public Works Department handles CIPs for bridge replacements, drainage improvements, and pavement management.[66]

[66] CIP Roads & Bridge Projects. https://www.frederickCountymd.gov/271/CIP-Roads-Bridge-Projects

Integrating forward-looking climate projections into project budgets during the scoping and planning phases ensures funding is allocated for resilience measures, such as retrofits to a stormwater drainage system that is likely to be flooded frequently by 2050.

Action 5A: Develop screening process for applying new Climate Adaptation and Resilience Criterion to CIP projects

Description: Include resilience considerations in the Capital Improvement Program process by developing a screening process for the new Climate Adaptation and Resilience criterion. This can resemble a cost-benefit analysis (e.g., project teams could briefly describe how the project would mitigate current and future climate risk(s); identify level of damage or disruption that could occur without the resilience measure (potentially referencing impacts described in the CRVA chapter); and estimate costs of additional construction, operations and maintenance needs of the resilience measure (including into out-years, for extent of asset/project life)). Compile the goals of the HMCAP and this CEAP to better understand how projects might help achieve them.

Additionally, project teams can further make the case for resilience efforts under other existing criteria, including:

- **Preserve infrastructure** (resilience measures could help protect infrastructure from climate damage and wear-and-tear)
- **Health or safety** (resilience measures could protect people from water contamination or extreme heat health risks)
- **Risk/liability of deferred maintenance of infrastructure** (climate change will become worse over time; investing in resilience now will save money by avoiding future damages and repair costs)
- **Number of citizens affected** (climate change will affect all of Frederick County; resilience measures can have a far reach in terms of their protection)

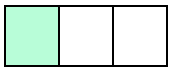
Lead Implementer(s):

Finance & Management

Energy and Environment

Emergency Management

Timeline:



Costs:

Staff time

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-18

Beneficiary Groups and Asset Groups:

- Various County divisions, including Finance, asset-owning divisions
- Various County assets
- County bond ratings (this will help with ESG reporting)

Action 5B: Integrate climate resilience into existing division-level CIP processes

Description: Review existing division-level CIP processes (e.g., DEE's program to help meet NPDES MS4 permit requirements; DPW's review of bridge replacements, drainage improvements, and pavement management) for opportunities to prioritize projects that not only address current needs, but also incorporate future-looking climate projections to estimate and address future risks. For example, this may include prioritizing stormwater pond retrofits in locations that are expected to experience increased flooding or that are designed to withstand a greater flood volume than current standards.

Lead Implementer(s):

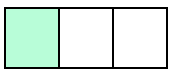
Finance & Management

Energy and Environment

Emergency Management

Public Works

Timeline:



Costs:

$

Links with HMCAP and Mitigation Actions:

- **Aligns** with **HMCAP Action FC-18**
- Potentially **aligns with HMCAP Action FC-34**

Beneficiary Groups and Asset Groups:

- Various County divisions, including Finance, asset-owning divisions
- Various County assets
- County bond ratings (this will help with ESG reporting)

Action 5C: Develop a policy for integrating climate considerations into transportation projects

Description: Develop County-wide policy for integrating climate considerations into projects submitted to the Transportation Improvement Program (TIP), including asking project submissions to detail their reductions in GHG emissions, avoidance of climate risks, and increasing climate resilience and/or including such factors in the review and selection process. This links with the MWCOG TIP process, where climate criteria are currently being discussed for inclusion in the selection process.

Lead Implementer(s):

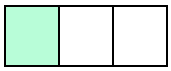
Transportation

Planning

Coordinate with MWCOG TIP process

Timeline:	**Costs:**
	$
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• N/A	• Various County divisions, including Public Works • Transportation networks

Action 5D: Review existing division operations budgets to identify opportunities for resilience

Description: The Operating budget is determined by both recurring expenses and new expenses as approved by the County Executive. Therefore, adding resilience into Operating appeal criteria could be approved by reviewing existing line items in divisions' proposed Operating budgets for alignment with climate risk and resilience. DEE can help divisions use the findings of the Climate Risk and Vulnerability Assessment chapter above to understand if existing expenses (such as facilities and infrastructure maintenance; emergency training) could also be used to address climate risks.	**Lead Implementer(s):** Energy and Environment, in coordination with divisions
Timeline:	**Costs:**
	Staff time, $ if additional technical expertise is needed
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• N/A	• Various County divisions • County bond ratings (this will help with ESG reporting)

Action 5E: Conduct regular monitoring and maintenance of facilities

Description: Conduct regular monitoring and preventative maintenance of critical County-managed facilities and assets; conduct cost tracking to identify potential damage trends related to inundation, extreme heat, or other climate hazards.	**Lead Implementer(s):** Public Works IT
Timeline:	**Costs:**
	$$
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• **Aligns with HMCAP Action FC-18**	• Various County divisions, including Finance, asset-owning divisions • Critical County-managed facilities and assets

Action 5F: Integrate resilience into retrofit programs and maintenance	
Description: Integrate resilience into retrofit programs and maintenance/repair schedules. Identify which County assets are more vulnerable to climate risks and budget for increased frequency of maintenance or earlier replacement as needed.	**Lead Implementer(s):** Public Works Planning
Timeline: 	**Costs:** $-$$
Links with HMCAP and Mitigation Actions: • **N/A**	**Beneficiary Groups and Asset Groups:** • Various County divisions, including asset-owning divisions • Various County assets

Strategy 6: Develop and adopt indicators and inter-division collaboration mechanisms to monitor and adaptively manage climate resilience measures over time

Existing County policies, plans, and programs:

ESG reporting

Implementation of strategies resulting from HMCAP

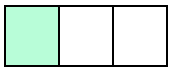
Implementing resilience solutions is an iterative process that requires a proactive approach. Each measure should be monitored and evaluated at regular intervals to ensure functionality and effectiveness so that adaptive management can take place if anything needs to change. A monitoring plan with established indicators or thresholds that can be used to track progress over time should be included with each measure. If a measure is not effective, alternative solutions can be developed, and lessons-learned from prior efforts can inform future action.

In addition, robust resilience solutions require an inter-divisional, collaborative approach to implementation. A working group that meets regularly and includes representatives across divisions can help advance climate adaptation and resilience initiatives in a coordinated manner, track progress, build awareness and capacity on CEAP actions, ensure that efforts are integrated and achieve efficiencies across divisions, and identify potential for co-benefits. Such a working group could include sub-groups that are coordinated around specific climate hazards or sectoral areas of action, such as stormwater or extreme heat or coordinating the County's response to multiple concurrent hazard events. The resilience actions detailed here demonstrate how the County can work across divisions to implement adaptive management of climate resilience measures over time.

Action 6A: Track resilience progress	
Description: Track progress internally and externally. Internally, collect data on progress towards integrating resilience across divisions (e.g., number of division emergency management/event response plans reviewed and updated). Externally, publish the monitoring and evaluation dashboard including indicators for success to track progress towards climate goals (both adaptation/resilience and mitigation).	**Lead Implementer(s):** Energy and Environment

Timeline:	**Costs:**
	Staff time
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• N/A	• Various County divisions, including Energy and Environment and IT

Action 6B: Ensure County coordination on implementing CEAP measures

Description: Ensure inter-division and intra-jurisdictional coordination across the County and with City of Frederick on climate change impacts and adaptation response. Establish CEAP implementation working group(s) to enable adaptive management and efficiencies in planning and budgeting for resilience. Potential working groups or sub-groups can focus on stormwater, extreme heat, and other topics necessitating close coordination across Divisions. Develop meeting protocols for the working group(s) and set up regular meeting schedule (e.g**.,** every 6 months).	**Lead Implementer(s):** Energy and Environment
Timeline:	**Costs:**
	Staff time
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• N/A	• Various County divisions, including Division of Energy and Environment

Strategy 7: Install generators/backup power at critical facilities

Existing County policies, plans, and programs:

Frederick County Climate Initiatives – Building Energy and Resilience Programs

Frederick County Climate Emergency Mobilization Workgroup

2022 Hazard Mitigation and Climate Adaptation Plan

Loss of electrical power is a common occurrence during a storm or extreme heat event and could increase in frequency as climate change increases risks associated with these types of extreme weather events. To reduce the consequences of outages, backup generators are installed at critical facilities such as hospitals, community centers, emergency response facilities, and shelters. Backup generators typically consist of a power source, a means of delivering energy from that source, and a way of isolating essential end uses for the power. Backup generators typically run on gas or diesel, but solar generators are gaining traction. All fire stations in the County have backup diesel generators that can supply power for 72 hours in the case of an emergency.

Another backup power resource are microgrids. Microgrids are small grids nested in the larger power grid that can serve interconnected loads in multiple buildings.[67] During a crisis, microgrids can operate on their own independent of the main grid using local energy generation. They are typically cleaner than backup generators since they run on battery storage or solar panels and consist of a solar PV system, a battery, a backup generator, and a control system. The Frederick County Climate Emergency Mobilization Workgroup (CEMWG) 2021 Report, MWCOG CEAP, and 2022 HMCAP call for an expansion of the installation and use of microgrids at critical facilities and in communities with vulnerable populations.

In December 2021, the County Executive launched a suite of initiatives to make the County more resilient to climate change. Among these was the creation of a program that deploys microgrids, combined heat and power technologies, and distributed energy generation solutions. Distributed energy refers to generation systems that are smaller than typical power plants and closer to the end consumer, such as rooftop solar arrays. As a result, a feasibility study is being conducted at the County facility on Himes Avenue to assess the potential of a solar photovoltaic installation with battery backup and a microgrid installation.[68, 69] A separate project will build a solar canopy in the parking lot outside the Bourne Building on Montevue Lane, which houses the County Parks and Recreation and Public Works divisions. The canopy will reduce electric costs for the building by 15-20%.[70] The resilience actions shown here expand on HMCAP actions to conduct a County-wide needs assessment for distributed energy generation, identify where additional available backup generators would have the greatest impact, and evaluate government buildings and critical facilities for solar potential.

Action 7A: Conduct a needs assessment for distributed energy generation	
Description: Conduct a County-wide needs assessment for distributed energy generation. Identify and prioritize where available backup generators and microgrids could best be utilized. Focus on opportunities to ensure continuity of operations when the main grid is down, especially for critical facilities.	**Lead Implementer(s):** Public Works Fire and Rescue Emergency Management Finance
Timeline: 	**Costs:** Staff time
Links with HMCAP and Mitigation Actions: • Aligns with HMCAP Action FC-11 and HMCAP Action FC-4	**Beneficiary Groups and Asset Groups:** • Various County divisions

[67] Ward, Matthew. May 3, 2022. What is the Difference Between A Microgrid and Backup Power? Retrieved from https://www.linkedin.com/pulse/whats-difference-between-microgrid-simple-back-up-power-matthew-ward

[68] Frederick County Office of Sustainability and Environmental Resources. 2021. "Budget Journal and Budget Ordinance Amendment to establish new Capital Projects for Climate and Energy within the Office of Sustainability and Environmental Resources." https://www.frederickcountymd.gov/DocumentCenter/View/334777/1214---Budget-Journal-and-Budget-Ordinace-Amendment---S-Moore-OSER

[69] McManus, Kevin. "Frederick County Government Out in Front On Using Solar Energy To Power Its Buildings." WFMD. November 7, 2022. https://www.wfmd.com/2022/11/07/frederick-county-government-out-in-front-on-using-solar-energy-to-power-its-buildings/

[70] Frederick County Office of the County Executive. 2021. "County Executive Announces New Clean Energy Project: County to Install Solar Canopy, EV Charging Stations at Bourne Building." April 22, 2021. https://www.frederickcountymd.gov/DocumentCenter/View/331816/Solar-Canopy-042221?bidId=

- Aligns with CEAP Mitigation Strategy 5: Building Electrification

Action 7B: Evaluate government buildings for solar potential

Description: Evaluate new and existing County and local government buildings, critical facilities, and infrastructure for solar potential and power storage. Prioritize these based on their ability to sustain safe, clean, efficient, and reliable backup solar power systems aligned with location, site characteristics, and operational needs.

Lead Implementer(s):

Public Works

Planning and Permitting

Finance

Timeline:

Costs:

Staff time

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-14
- Aligns with CEAP Mitigation Strategy 1: 100% Renewable Energy

Beneficiary Groups and Asset Groups:

- Various County divisions

Action 7C: Install microgrids and solar infrastructure

Description: Plan and budget for installation of microgrids, solar power infrastructure, offsite generation, power purchase agreements (PPAs), and backup generators in priority locations based on the findings from Actions 7A and 7B. Begin the first steps towards implementation.

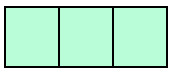
Lead Implementer(s):

Public Works

Planning and Permitting

Finance

Timeline:



Costs:

Staff time

$-$$$

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-14 (solar potential) and Action FC-32 (microgrids)

Beneficiary Groups and Asset Groups:

- Various County divisions, including Water and Sewer Utilities, IIT, Public Works
- County facilities

5.2.2 Flooding: Overall

Strategy 8: Develop deeper understanding of flood vulnerabilities

Existing County policies, plans, and programs:

Weather and flood monitoring and communication systems

County-specific flood information and regulations

Flooding poses a great risk to County assets, infrastructure, and operations. An improved understanding of high-risk flood areas, particularly in relation to vulnerable communities, will enable the County to design and implement effective flood mitigation and control strategies. Currently, FEMA is updating the County's Flood Rate Insurance Maps (FIRMs), which delineate the 100-year and 500-year storm floodplains. Once the updated maps are published, the County's Emergency Management and Stormwater divisions are planning to work with a consultant to assess the likelihood of flood inundation across the County. In addition, FCG uses various sources for real-time flooding information and emergency notifications/communications, including NOAA, USGS, and the National Weather Service. Information from these existing systems can help add detail and nuance to the County's understanding of high-flood risk areas and the FIRMs.

The 2022 HMCAP performed a flood analysis to determine which buildings and populations were at risk during a high intensity flood, finding that two city wastewater treatment plants, a MARC transit station, and a Frederick County volunteer fire company fire station are in the 20-year or 100-year floodplains and identifying several census tracts with high populations that are close to a FEMA Special Flood Hazard Area. However, the FEMA floodplains do not account for future climate projections, such as increased winter precipitation or more frequent heavy rainfall events that may extend the floodplain area.

The State's Stormwater Management Law, Environment Article 4-201.1, now requires the Maryland Department of the Environment (MDE) to report on the most recent precipitation data available, investigate flooding events since 2000, and update Maryland's stormwater quantity management standards for flood control. MDE will be making updates to the stormwater management regulations and other regulations adopted pursuant to this statute. In 2021, MDE published an Advancing Stormwater Resiliency in Maryland (A-StoRM) roadmap with Maryland's Stormwater Management Climate Change Action Plan. In 2022, MDE is reaching out to various Statewide stakeholders to assist in developing and implementing new initiatives generated from the A-StoRM process. FCG will update County-specific flood information and regulations as needed based on the updates from MDE's A-StoRM efforts. This County CEAP and the climate risk and vulnerability assessment completed (see Chapter 4) will inform these actions as part of the A-StoRM and other regulatory processes.

Action 8A: Identify high flood risk locations

Description: Using the updated FIRMs and informed by future climate risk projections, identify high flood risk locations and assets to help prioritize resilience investments.

Other sources for identifying high-risk areas include existing weather and flood monitoring systems, road closures, pluvial flood analysis from the 2022 HMCAP, analysis of inundated buildings, population density, issues reported through the Community Flood Map and Hazard Mitigation Survey, and historic rescue locations. Coordinate with future updates through Maryland's Stormwater

Lead Implementer(s):

Planning and Permitting

Energy and Environment

Emergency Management

Management Climate Change Action Plan (forthcoming) and consultant team support to check building elevations in relation to flood exposure.

Timeline:

Costs:

Staff time – $ (Potential consultant)

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-12

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions

Action 8B: Follow A-StoRM process and conduct studies/updates as needed to stormwater management processes, informed by climate projections

Description: Participate in MDE's A-StoRM process as a member of technical committees (including the Regulatory Committee) and identify and document frequently flooded areas since January 2000 and related stormwater quantity management measures.

- When requirements are developed, conduct County-wide watershed assessments to develop watershed-specific flood management plans and feasibility assessments on regulated flooding areas. Note that FCG's Emergency Management staff, working with a consultant, are planning to conduct studies that will align with this requirement.
- When MDE publishes regulations with new storage volumes required for development, update County codes and ordinances to reflect the change.

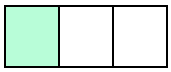
Lead Implementer(s):

Emergency Management

County participants in the R-TAG Committee; coordination with Maryland Municipal Stormwater Association (MAMSA)

Planning and Permitting

Timeline:



Costs:

Staff time

Links with HMCAP and Mitigation Actions:

- N/A

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions
- Various assets (those at-risk to flooding)

Strategy 9: Build overall resilience to stormwater flooding

The County is implementing best management practices to capture and treat stormwater runoff. The County participates in the National Flood Insurance Program (NFIP), which incentives flood management by offering flood insurance to communities that enforce floodplain development regulations. The County's Stormwater Restoration Plan includes a multi-faceted approach to build flooding resilience using stormwater management practices such as bioretention, pond retrofits, riparian buffer planting, and stream restoration. In some areas, such as Clover Hill, the County is already repairing stormwater infrastructure to prevent future water damage to homes during heavy rainfall events.

Existing County policies, plans, and programs:

Frederick County 2021 Stormwater Restoration Plan

County Stormwater Management Best Practices

Housing permits

Actions under this Strategy seek to expand upon the good practices already underway and focus on incorporating future climate projection considerations into maintenance of stormwater infrastructure.

Action 9A: Increase water storage through pond retrofits

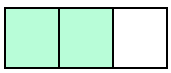
Description: Increase water storage in stormwater infrastructure when possible during the retrofitting of ponds—without creating any significant or high-hazard dams. Increase stormwater treatment volumes in retrofits as possible within site constraints. Note that this aligns with MDE guidance, which incentivizes capturing more stormwater than required.

Lead Implementer(s):

Planning and Permitting

Emergency Management

Timeline:



Costs:

$$-$$$

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-37
- Aligns with CEAP Mitigation Strategy 3: Green Building Standards

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions, including Energy and Environment
- Culverts and other stormwater infrastructure

Action 9B: Increase culvert capacity

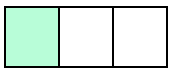
Description: Create a plan and implement projects to increase culvert (and other stormwater infrastructure) capacity throughout the County based on the state's updated regulations. Provide technical assistance to municipalities to replace undersized or deteriorated culverts to make them resilient to future climate impacts. Where applicable, identify opportunities to implement nature-based solutions to reduce stormwater flow. Monitor sites where frequent flooding is known to occur for maintenance needs and account for ongoing maintenance costs in capital planning.

Lead Implementer(s):

Energy and Environment

Public Works

Timeline:	**Costs:**
	$$-$$$
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• Aligns with HMCAP Action FC-34	• Public • Municipalities • Various County divisions, including Energy and Environment • Culverts and other stormwater infrastructure

Action 9C: Update housing permit requirements	
Description: Update housing permits to require building envelope openings (e.g., windows, doors) to be elevated above any anticipated surface water levels from flooding events. Additionally, basement walkout elevations and parcel/lot grading should be above known groundwater or calculated surface water flow elevations.	**Lead Implementer(s):** Planning and Permitting
Timeline:	**Costs:**
	Staff time
Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• N/A	• Public • County divisions, including Stormwater • Emergency Management, Fire and Rescue Services • Various asset groups

5.2.3 Flooding: Interruptions in Services/Use

Strategy 10: Prevent flood-related interruptions to County services and/or use of County assets

Existing County policies, plans, and programs:

Transportation maintenance

Paratransit program

Flooding can destroy or damage roads, bridges, parks, and facilities, impairing the use of infrastructure and assets until construction or repairs are completed. Damage to routes during a flood can impair the ability of first responders to reach those in need and of residents to evacuate high-risk areas. The resilience actions shown here describe ways in which the County can reduce the impact and extent of flood-related interruptions to County services and the use of County assets. Action 10A recommends creating a County-wide flood working group that would coordinate division response to a flood event and minimize flood-related damages. Action 10B aims to prevent roadways and bridges from becoming impassable during a flood event.

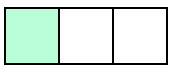
Action 10A: Create a County-wide flood working group

Description: Create FCG-wide flood working group. This strategy aims to create a collaboration framework for stormwater and flooding issues. This would lay out approach for preparing for (including issuing flood warnings to divisions), withstanding, and recovering from flood events. This aligns with Action 6B above (ensure County coordination on implementing CEAP measures) and can be part of overall resilience coordination efforts.

Lead Implementer(s):

Emergency Management

Timeline:



Costs:

Staff time, $ for potential consultant

Links with HMCAP and Mitigation Actions:

Beneficiary Groups and Asset Groups:

- Various County divisions
- County assets at risk of flooding

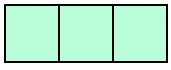
Action 10B: Reduce risk of impassable routes during flood events

Description: Reduce risk of impassable routes during flood events. Conduct mitigation projects on bridges to address inadequate waterway openings and inadequate capacity for emergency response equipment. Develop structural corrective action plans (paving/elevation programs, culverts) for Frederick County's pre-identified frequently flooded roadways. Ensure that paratransit options are available and accessible during flood events.

Lead Implementer(s):

Public Works

Timeline:



Costs:

$$$

Links with HMCAP and Mitigation Actions:

Beneficiary Groups and Asset Groups:

- Public, including paratransit users

• Aligns with HMCAP Action FC-33 and Action FC-34	• Various County divisions, including Fire and Rescue Services • Transit Services

Strategy 11: Increase resilience of County infrastructure to flood-related damage

Existing County policies, plans, and programs:

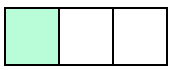
Building codes

Inadequate flood control systems can result in costly and damaging impacts to County infrastructure. Flooding can overtop and erode roads, clog drainage systems with debris, and damage bridges and culverts. Hardening infrastructure to handle higher volumes and more intense flows projected to occur as a result of climate change will help the County avoid future damage and repair costs.

As mentioned in Strategy 8 above, FEMA is currently updating the County's Flood Rate Insurance Maps (FIRMs), which delineate the 100-year and 500-year storm floodplains. The new maps, set to go into effect in July 2023, require an update of code provisions based on the new floodplains for the County to maintain its participation in the National Flood Insurance Program. The new maps, in combination with climate change projections, can help target areas to invest in flood hardening, and the updated codes may also require flood-hardening measures.

Action 11A aligns with the 2022 HMCAP to increase the freeboard clearance from 1 foot to 2-3 feet to enhance flood protection and to add "repetitive loss" considerations to development regulated by County ordinances. This will extend the Increased Cost of Compliance in flood insurance policies to cover an additional $30,000 and bring damaged properties into compliance with the ordinance. Freeboard is a factor of safety expressed in feet above a flood level and compensates for factors other than the design flood height and floodway conditions.[71] Raising the freeboard above standard levels will increase the likelihood that floodwaters do not damage properties or infrastructure. The Frederick County Climate Emergency Mobilization Working Group recommends revising planning and permitting for wastewater and stormwater infrastructure to encompass flood projections for the 100-year storm.

Action 11A: Update building code provisions for flood-prone areas

Description: Update building code provisions related to building in flood-prone areas (update extent of these areas, taking climate change into account). Increase the building freeboard requirement by modifying the Flood Protection Elevation definition (change from 1 ft to 2 or 3 ft). Add "repetitive loss" to development regulated by the County ordinances to allow extension of the Increased Cost of Compliance coverage in flood insurance policies.	**Lead Implementer(s):** Planning and Permitting
Timeline: 	**Costs:** Staff time

[71] FEMA. Freeboard. https://www.fema.gov/glossary/freeboard.

Links with HMCAP and Mitigation Actions:	Beneficiary Groups and Asset Groups:
• Aligns with HMCAP Action FC-1 • Aligns with CEAP Mitigation Strategy 3: Green Building Standards	• Public • Property owners • Various County divisions, including Facilities • Buildings and facilities in flood-prone areas

Action 11B: Harden physical resilience for assets and facilities

Description: Invest in physical resilience measures to vulnerable assets and facilities. Based on the findings of the CRVA, targets for this investment may include sewer facilities, water treatment plants, transportation infrastructure, fleet, parks, cultural and historic assets, backup generators, County facilities, and landfill.	**Lead Implementer(s):** Public Works
Timeline: 	**Costs:** $$$
Links with HMCAP and Mitigation Actions: • N/A	**Beneficiary Groups and Asset Groups:** • Various County divisions • County assets at risk of flooding

5.2.4 Flooding: Contamination and Human Health

Strategy 12: Understand and reduce risk of water contamination

Existing County policies, plans, and programs:

Lake Linganore Source Water Protection Plan

Livable Frederick Master Plan – Water Quality Goal

County Stormwater Management Best Practices

Division of Energy and Environment Water Quality Monitoring

- Frederick County Stream Survey
- Restoration Monitoring
- Concentrated Long Term Monitoring

Changes in the frequency and intensity of precipitation due to climate change can affect water quality. Heavier rainstorms lead to increased surface runoff, which can pick up pollutants, chemicals, and other contaminants as runoff flows over the ground and into bodies of water.[72] Runoff can also be higher in temperature than recipient bodies of water, causing challenges for local species. During events with extreme runoff, wastewater treatment plants can reach capacity, leading to untreated contaminated water entering local waterways. Implementing flood mitigation measures to prevent overflow of sewer systems, landfills, and other areas with contaminants is critical to protect the County's clean water supply.

The Livable Frederick Master Plan aims to improve and protect water quality by eliminating pollution to local waterways and adequately funding and implementing water quality restoration efforts. Water quality initiatives in the plan can be enhanced by integrating forward-looking precipitation projections and future flood risk. For example, understanding which areas are at high risk of future flooding can guide the implementation of best management practices to reduce sedimentation, erosion, and run-off. The HMCAP did not contain strategies for mitigating the specific risks of human health consequences of flooding, including exposure to contaminated floodwaters and contaminants flowing into waterways. The County is asking residents to implement best management practices such as rain gardens, rain barrels, bioretention areas and bioswales that slow or absorb stormwater runoff carried over impervious surfaces.[73]

The County currently runs several stream health and water quality monitoring programs through the Division of Energy and Environment, including hotspot outfall water quality monitoring, an instream water quality monitoring site, an annual County-wide stream survey that is used to determine overall stream health which is used to identify restoration projects. The resilience actions listed here aim to identify high-risk areas for water contamination to prevent water quality degradation before runoff reaches a water body.

Action 12A: Understand likely sewer system overflows during flood events

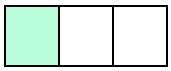
Description: Conduct survey(s) to understand where significant incidents are probable during flooding events such as sewer system overflows and contaminant/pollutant flows, and additional requirements that may be needed for (e.g., slope stabilization around County landfill properties). The County is currently conducting pluvial modeling to examine flooding risks from a stormwater and road	**Lead Implementer(s):** Water and Sewer Utilities Solid Waste Services Energy and Environment

[72] Fecht, Sarah. 2019. How Climate Change Impacts Out Water. Columbia Climate School. https://news.climate.columbia.edu/2019/09/23/climate-change-impacts-water/.

[73] Sustainable Frederick County. Best Management Practices. https://frederickCountymd.gov/7577/Best-Management-Practices.

closure perspective; the results from this modeling can inform this strategy.

Timeline:



Costs:

$

Links with HMCAP and Mitigation Actions:

- N/A

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions
- Sewer system and landfill assets

Action 12B: Implement flood risk reduction measures

Description: Implement flood risk reduction measures (grey/green infrastructure, bioswales, upstream flow reduction, etc.) at/around high-risk areas to reduce likelihood of overloaded sewer system and contaminated flows. This ties to Strategy 4 on green infrastructure as well as Strategy 9 above, which focuses on building overall resilience to stormwater flooding.

Lead Implementer(s):

Water and Sewer Utilities

Energy and Environment

Timeline:

Costs:

$$-$$$

Links with HMCAP and Mitigation Actions:

- Aligns with CEAP Mitigation Strategy 8: Waste Management (landfill improvements)

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions
- Sewer system

Action 12C: Stream restoration activities

Description: Implement stream restoration projects which re-connect streams back into their floodplains while also providing floodplain storage, protection of County assets along the stream channel, and reduce failing stream banks. These projects will assist in providing additional stormwater runoff storage. Additionally, armoring or design the project to protect County assets such as sewer and water crossings along the stream corridor will reduce future asset exposures or damages.

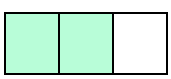
Lead Implementer(s):

Energy and Environment

Public Works

Water and Sewer Utilities

Timeline:



Costs:

$$

Links with HMCAP and Mitigation Actions:

- Aligns with Aligns with HMCAP Actions FC-3; FC-30.

Beneficiary Groups and Asset Groups:

- Public
- Property Owners

- County divisions, including Public Works, Energy and Environment, Water and Sewer Utilities
- County Facilities

5.2.5 Heat: Human Health

Strategy 13: Protect human health from extreme heat

Existing County policies, plans, and programs:

Cooling centers in Frederick County

Frederick County Health Department Hot Weather Tips

Frederick County Risk Management Policy

County Heat Stress Policy

Extreme heat can negatively impact human health, particularly among the elderly and those with underlying health conditions. In addition, low-income populations and those who may not have access to reliable cooling are vulnerable. Heat waves are projected to become more severe due to climate change, putting additional stress on outdoor workers and vulnerable populations. While the County already has high heat standard operating procedures (SOPs) in the Risk Management Policy and warning systems in place for outdoor workers, an increase in high heat days may place further personnel or populations at risk and lead to reduced hours available to work or deliver County services. To prepare for future extreme heat events, the County can conduct research to better understand how heat affects employees and residents, strengthen educational outreach on heat events, and update County policies to account for increased frequency and intensity of extreme heat.

The Frederick County Climate Emergency Mobilization Work Group recommends improving community public health resilience to extreme heat events in several ways, including increasing access to cooling centers, establishing an early warning Heat Health Alert System, and increasing education and outreach programs. Actions 13A and 13C recommend conducting public surveys to enhance understanding of heat impacts on County service delivery, workers and the public. The knowledge gained from the surveys should be used to update the County's existing heat stress policies and cooling services (Actions 13B and 13D, respectively).

Action 13A: Understand impacts of heat on service delivery

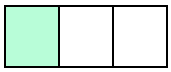
Description: Conduct a survey to understand heat impacts on County service delivery. This can include: surveying existing high-heat SOPs that protect worker health and safety and whether or not they are sufficient given climate projections; understanding the effects of various SOPs and temperature thresholds (such as the "acclimated" requirements) on work hours and service delivery; identifying opportunities for heat policy adjustments or additional policies along the lines of the Adverse Heat Conditions policy in use by the Parks and Recreation Division.

Lead Implementer(s):

Office of Public Health Preparedness

Risk Management

Timeline:



Costs:

Staff time

Links with HMCAP and Mitigation Actions:

Beneficiary Groups and Asset Groups:

- N/A

- Outdoor Workers

Action 13B: Update heat stress policy

Description: Update County Heat Stress Policy to account for worker health and safety in the face of increased frequency and intensity of extreme heat and understanding of heat stress impacts on the body. Account for contingencies related to service delivery and workload management due to reduction in safe work hours during high heat events. Include regular updates on heat risk during the County's Safety Committee meetings.

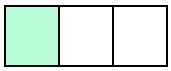
Lead Implementer(s):

Health Department

Emergency Management

Risk Management

Timeline:



Costs:

Staff time

Links with HMCAP and Mitigation Actions:

- N/A

Beneficiary Groups and Asset Groups:

- Outdoor Workers

Action 13C: Conduct public survey on cooling services

Description: Conduct a public survey on cooling options to determine demand and value of not only cooling centers, but also cooling services such as direct in-home support to elderly residents and other options. As part of this process, assess existing and future cooling services based on extreme heat projections and needs of vulnerable populations in heat emergency events (consider accessibility, language interpreters, backup power support, medical assistance, and food and water supplies) to determine adequacy. Facilitate sharing of lessons learned between various Divisions providing cooling services.

Lead Implementer(s):

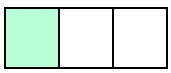
Health Department

Emergency Management

Senior Services

Citizens Services

Timeline:



Costs:

$

Links with HMCAP and Mitigation Actions:

- N/A

Beneficiary Groups and Asset Groups:

- Public

Action 13D: Adjust cooling services

Description: Based on survey results from Action 13C, adjust or develop County-run cooling services to meet the needs of vulnerable populations and the public.

Lead Implementer(s):

Health Department

Emergency Management

Senior Services

Citizens Services

Timeline:	**Costs:**
	$-$$

Links with HMCAP and Mitigation Actions:	**Beneficiary Groups and Asset Groups:**
• N/A	• Public

Action 13E: Conduct heat awareness campaigns

Description: To proactively address the anticipated higher risk of heat-related illness in the public due to an increase in number and intensity of high-heat days, conduct awareness campaigns to help the public understand the risk of high heat and risk mitigation strategies and cooling resources. Plan for surge capacity at health center during high-heat events. Budget for trainings and resources to protect first responders during extreme heat events.	**Lead Implementer(s):** Health Department Emergency Management Fire and Rescue
Timeline: 	**Costs:** $
Links with HMCAP and Mitigation Actions: • N/A	**Beneficiary Groups and Asset Groups:** • Public • Various County divisions, including Fire and Rescue Services • Health Department

5.2.6 Heat: Stress to Infrastructure

Strategy 14: Increase resilience of County infrastructure to extreme heat

Existing County policies, plans, and programs:

Building codes

Building and facility management provisions

Extreme heat can damage infrastructure and assets across sectors, including County facilities, transportation systems, and water supply and stormwater infrastructure. Factoring heat considerations into infrastructure design, development, retrofits, and upgrades will enhance the ability of County infrastructure, such as bridges, roads, and buildings, to operate at full capacity during extreme heat events.

Action 14A aligns with Action FC-6 from the 2022 HMCAP, which recommends updating building and zoning codes to promote the implementation of green roofs and green infrastructure to help mitigate extreme heat.[74] Green infrastructure, discussed in Strategy 4, exhibits the same cooling characteristics as green roofs while

[74] Green roofs are vegetative layers grown on rooftops. The vegetation on the roof removes heat from the air through evapotranspiration and provides shade, cooling the surrounding air. Green roofs can be installed on any type of building, including government and industrial facilities and offices. See: U.S. Environmental Protection Agency. 2017. Reducing Urban Heat Islands: Compendium of Strategies Green Roofs. Available at: https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_3.pdf.

providing an essential service, such as stormwater filtration or flood control.[75] Amending building code provisions—as well as incorporating heat stress into building management practices and design standards (as under Actions 14B and 14D)—can help prevent future power outages that occur as a result of high electricity demand during heat events and protect building users.

Action 14A: Update building and zoning codes to promote cooling

Description: Update building and zoning codes as needed to allow for and promote the implementation of cool roofs, tree planting, etc. to help mitigate extreme heat in developed areas and County facilities.

Lead Implementer(s):

Planning and Permitting

Public Works

Timeline:

Costs:

Staff time

Links with HMCAP and Mitigation Actions:

- Aligns with HMCAP Action FC-6
- Aligns with CEAP Mitigation Strategy 3: Green Building Standards.

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions, including Facilities
- Buildings
- Green infrastructure

Action 14B: Incorporate heat stress into building and facility management provisions

Description: Incorporate County heat stress policy into building management provisions to build resilience to brownouts and manage labor during high heat events.

Lead Implementer(s):

Planning and Permitting

Public Works

Timeline:

Costs:

Staff time

Links with HMCAP and Mitigation Actions:

- N/A

Beneficiary Groups and Asset Groups:

- Public
- Various County divisions, including Facilities
- Buildings, energy infrastructure

Action 14C: Conduct freshwater modeling

Description: Conduct modeling to understand how freshwater/surface water supply would be affected under climate change scenario(s). Coordinate with concurrent efforts, including by MWCOG (i.e., groundwater depth monitoring, Drought Response Plan).

Lead Implementer(s):

Water and Sewer Utilities

Coordinate with MWCOG

Timeline:

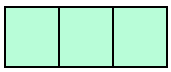
Costs:

$

[75] The Trust for Public Land. 2016. "The benefits of green infrastructure for heat mitigation and emissions reductions in cities". Available at: https://www.tpl.org/benefits-green-infrastructure-heat-mitigation-and-emissions-reductions-cities.

Links with HMCAP and Mitigation Actions:	Beneficiary Groups and Asset Groups:
• N/A	• Water and Sewer Utilities • Water supply

Action 14D: Invest in physical heat resilience measures and design standards

Description: Invest in physical resilience measures to vulnerable assets and facilities. Based on the findings of the CRVA, targets for this investment may include efforts to ensure heat resistance of water and wastewater treatment plant electric equipment and water discharge facilities, fleet, trees and wetlands, and contamination controls at landfills.	Lead Implementer(s): Various County divisions, coordinated by Energy and Environment
Timeline: 	Costs: $-$$$
Links with HMCAP and Mitigation Actions: • N/A	Beneficiary Groups and Asset Groups: • Public • Various County divisions, including Water and Sewer Utilities, Public Works, Parks and Recreation, Solid Waste and Recycling • Various County assets at risk of extreme heat

5.3 Monitoring Progress

In order to ensure that the County's climate resilience goals are achieved, it is important to monitor progress and periodically update next steps. Monitoring includes updates on progress towards implementing the actions laid out in this plan. It also means regularly updating the website to help readers understand what risk the County is facing and the importance of building resilience to climate change.

6 Next Steps

Frederick County has an opportunity to lead by example through adopting sustainable and resilient operational practices and taking measures to reduce the government's GHG footprint. This Climate and Energy Action Plan describes actions that Frederick County can take to incorporate climate change considerations into government operations, reduce its footprint, save money, create healthier and safer working conditions for County employees, protect economic activity, and increase resilience to the impacts of climate change. This builds upon the County's existing work on sustainability and resilience that will reduce energy and fuel use, curb future GHG emissions, and ultimately save costs over time.

Throughout implementation of the mitigation and resilience strategies described in this plan, the County will need to take steps to institutionalize climate action in its operations --for example, conducting regular monitoring of progress and establishing reporting processes and accountability. The County may also need to address cost differences (particularly upfront costs) as it incorporates climate change considerations into its policies and processes.

To reduce its GHG emissions, the County will need to continue implementing and prioritizing actions that reduce building energy use, prioritize carbon-free or renewable energy, and incorporate electric and alternative fuel vehicles into its fleet.

Increasing climate resilience is also essential for the County to responsibly manage its assets and infrastructure. To do this, Frederick County Government needs to prioritize:

- Updating policies, plans, programs, and budgets to consider climate impacts
- Implementing physical measures to protect County infrastructure
- Collaborating across divisions on implementing solutions

Implementation of this plan will require support across agencies and staff as well as the funding to take action. Ultimately, implementation of the CEAP will help Frederick County meet its climate change goals and demonstrate its commitment to address climate change.

7 References

AccuWeather. "Frederick Maryland." Accessed November 17, 2022 from https://www.accuweather.com/en/us/frederick/21701/october-weather/329303?year=2021

Center for Climate and Energy Solutions. 2019. What is Climate Resilience and Why Does it Matter? Available at: https://www.c2es.org/wp-content/uploads/2019/04/what-is-climate-resilience.pdf.

Centers for Disease Control and Prevention, the Agency for Toxic Substances and Disease Registry/Geospatial Research, Analysis, and Services Program. 2018. CDC/ATSDR Social Vulnerability Index. Database Maryland. Accessed on November 24, 2021. Available at: https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html.

Climate Emergency Mobilization Work Group. 2021. "Climate Response and Resilience." Available at: https://frederickcountymd.gov/DocumentCenter/View/336544/Vol1FredClimateReport2021Finalsml.

Climate.gov. 2020. "Climate Change: Atmospheric Carbon Dioxide." Available at: https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

County Council of Frederick County, Maryland. 2020. "Resolution No. 20-22." Available at: https://frederickcountymd.gov/DocumentCenter/View/328669/20-22-Climate-Emergency.

Dupigny-Giroux et al. 2018. "Northeast." In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. U.S. Global Change Research Program, Washington, DC. Available at: https://nca2018.globalchange.gov/chapter/18/.

Federal Emergency Management Agency (FEMA). Wright, James. 2007. "Chapter 2: Types of Floods and Floodplains" in Floodplain Management: Principles and Current Practices. Available at: https://training.fema.gov/hiedu/aemrc/courses/coursetreat/fm.aspx.

Federal Emergency Management Agency (FEMA). 2018. "National Flood Insurance Program Community Rating System". Available at: https://www.fema.gov/floodplain-management/community-rating-system.

Federal Emergency Management Agency (FEMA). "Nature-based Solutions." Accessed on May 12, 2022. Available at: https://www.fema.gov/emergency-managers/risk-management/nature-based-solutions.

First Street Foundation. 2020. Flood Factor. Accessed February 28, 2022. Available at: https://www.floodfactor.com/county/frederick-county-maryland/24021_fsid.

Frederick County Office of Environmental Sustainability (now Department of Energy and Environment). N.d. "Sustainable Action Plan for County Operations." Available at: https://frederickcountymd.gov/DocumentCenter/View/16111/Sustainable-Action-Plan-for-County-Ops_Final072.

Frederick County Hazard Mitigation Planning Committee. 2022. "2022 Hazard Mitigation and Climate Adaptation Plan". Available at https://www.frederickcountymd.gov/DocumentCenter/View/337780/Frederick-County-Hazard-Mitigation-and-Climate-Adaptation-Plan---for-.

Frederick County Hazard Mitigation Planning Committee (HMPC). 2017. "Frederick County Hazard Mitigation Plan".

Hayhoe, K., D.J. Wuebbles, D.R. Easterling, D.W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose, and M. Wehner, 2018: Our Changing Climate. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144. doi: 10.7930/NCA4.2018.CH2

Headwater Economics. 2022. "Populations at Risk: Maryland". Prepared for the U.S. Census Bureau, American Community Survey Office, Washington, D.C. Available at: headwaterseconomics.org/par.

Insurance Service Office. Building Code Effectiveness Grading Schedule (BCEGS®). Accessed on May 13, 2022. Available at: https://www.isomitigation.com/bcegs/.

Intergovernmental Panel on Climate Change's (IPCC). 2018: Summary for Policymakers. Available at: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_HR.pdf.

Lindsey, Rebecca. 2021. Understand the Arctic polar vortex. NOAA. Accessed June 30, 2022. https://www.climate.gov/news-features/understanding-climate/understanding-arctic-polar-vortex

Maryland Energy Administration. 2020. "Frederick County Revs Up New Electric Buses with Help from the Maryland Energy Administration." Available at: https://news.maryland.gov/mea/2020/09/29/frederick-county-revs-up-new-electric-buses-with-help-from-the-maryland-energy-administration/.

Maryland Department of Legislative Services. 2022. Senate Bill 348: Conservation Finance Act. Available at: https://mgaleg.maryland.gov/mgawebsite/Legislation/Details/sb0348?ys=2022RS.

Metropolitan Washington Council of Governments. 2020. "Metropolitan Washington 2030 Climate and Energy Action Plan." Available at: https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/.

Moore, Shannon. 2020. "Baseline, Goals, Regional Coordination, and Frederick County Plans and Actions to Date". Frederick County Office of Sustainability and Environmental Resources. Available at: https://frederickcountymd.gov/DocumentCenter/View/326825/ClimateChange-WF.

NOOA National Weather Service. 2022. Applied Climate Information System. Accessed March 1, 2022. https://www.weather.gov/wrh/Climate?wfo=lwx. Based on data gathered in Hagerstown and Emmitsburg, MD.

National Integrated Drought Information System (NDIS) "Drought Conditions for Frederick County", Accessed February 2022. Available at: https://www.drought.gov/states/maryland/county/frederick.

NOAA National Severe Storms Laboratory. 2022. Severe Winter Weather 101. Accessed April 24, 2022.

Office of the County Executive. 2017. "Sustainable Frederick County." Available at: https://frederickcountymd.gov/DocumentCenter/View/298543/A-New-Framework-for-Sustainability-2017.

Office of the County Executive. 2021. "Executive Gardener Launches Climate Initiatives," Available at: https://frederickcountymd.gov/DocumentCenter/View/334743/Climate-Initiatives-120721.

Occupational Health and Safety Administration (OSHA). n.d. "Using the Heat Index: A Guide for Employers." Available at: https://www.osha.gov/SLTC/heatillness/heat_index/.

Scientific and Technical Working Group. 2008. Comprehensive Assessment of Climate Change Impacts in Maryland: Report to the Maryland Commission on Climate Change. https://mde.maryland.gov/programs/Air/ClimateChange/Documents/FINAL-Chapt%202%20Impacts_web.pdf

The Trust for Public Land. 2016. "The benefits of green infrastructure for heat mitigation and emissions reductions in cities". Available at: https://www.tpl.org/benefits-green-infrastructure-heat-mitigation-and-emissions-reductions-cities.

Thomure, Dale. 2016. BCEGS® Spotlight: Washington County, Maryland. Accessed July 4, 2022. https://www.isomitigation.com/newsletter/fall-2016/bcegs-spotlight-washington-county-maryland/

U.S. Environmental Protection Agency (EPA). "Climate Change Indicators: Heat Related Deaths". Last updated October 2021. Available at: https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths#ref10.

U.S. Environmental Protection Agency (EPA). "What is Green Infrastructure?". Accessed on May 12, 2022. Available at: https://www.epa.gov/green-infrastructure/what-green-infrastructure.

U.S. Environmental Protection Agency. 2017. Reducing Urban Heat Islands: Compendium of Strategies Green Roofs. Available at: https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_3.pdf.

U.S. Climate Resilience Toolkit. 2021. U.S. Climate Explorer. Accessed January 2022. Available at: https://crt-climate-explorer.nemac.org/.

U.S. Global Change Research Program. 2014. "Chapter 28: Adaptation. Climate Change Impacts in the United States: The Third National Climate Assessment." Available at: https://nca2018.globalchange.gov/chapter/28/.

U.S. Global Change Research Program. 2017. "Climate Science Special Report." Fourth National Climate Assessment, Volume I. Available at: https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf.

U.S. Global Change Research Program. 2018. Fourth National Climate Change Assessment. "Chapter 2: Our Changing Climate". Available at: https://nca2018.globalchange.gov/chapter/2/.

U.S. White House. 2021. FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies. Available at

https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.

Van Slyke, Ashley. 2020. America's Legacy of Redlining: State Sponsored Segregated and Disenfranchisement of Urban Minority Communities. Lerner Center Issue Brief #35, Syracuse University. Available at: https://lernercenter.syr.edu/wp-content/uploads/2020/07/VanSlyke_Redlining_Final.pdf.

8 Technical Appendix A: Inventory Methods

COG collected data from Frederick County employees to complete the Local Government Operations (LGO) GHG Inventories for years 2010 and 2018. ICLEI's Local Government Operations Protocol (LGOP) was followed for these inventories. The Protocol strongly encourages local governments to utilize operational control when defining their organizational boundary. A local government has operational control over an operation if the local government has the full authority to introduce and implement its operating policies at the operation. This approach is consistent with the current accounting and reporting practice of many organizations that report on emissions from facilities, which they operate. COG used this boundary definition for Frederick County's 2010 and 2018 GHG inventories.

A local government's emissions inventory should comprise all GHG emissions occurring during a selected calendar year. Reporting GHG inventories on a calendar year basis is considered standard internationally. Emissions were calculated based on the result of an activity that the local government had operational control over. Activity data were multiplied by emission factors to estimate GHG emissions from each source. Emission factors relate the quantity of a GHG emitted in the atmosphere with an activity and are expressed as the quantity of a GHG divided by a unit for the activity (for example, kilograms of carbon dioxide emitted per gallon of motor gasoline burned). This inventory relies on emission factors from the ICLEI Local Government Operations Protocol (LGOP) and U.S. EPA's Emissions & Generation Resource Integrated Database (eGRID).

ICLEI's ClearPath tool is an online tool for preparing local GHG inventories, forecasts, climate action plans, and monitoring reports. The tool is consistent with both U.S. and global accounting protocols. COG uses the Government Inventory Module in the ClearPath tool to complete LGO GHG inventories.

8.1 Buildings and Energy Use Sector

8.1.1 Purchased Electricity

Annual electricity use data were provided by the County for inventory years 2010 and 2018 via EPA's EnergyStar Portfolio Manager. COG used the U.S. EPA's eGRID emission factors to calculate emissions from this electricity use data. eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States, and tracks data on emissions, emission rates, generation, heat input, resource mix, and other attributes.[76] To calculate emissions of carbon dioxide equivalent (CO_2e), COG applied electricity emission factors from the eGRID data for the Reliability First Corporation East (RFCE) subregion for 2010 and 2018.

Electricity use was projected for 2019 through 2050 using County population estimates from COG's Cooperative Forecast 9.1a. Electricity use for 2011 to 2017 was interpolated linearly from 2010 and 2018 use. Electricity use estimates included in the Business As Usual (BAU) scenario do not account for any energy conservation measures, energy efficiency programs or policies, renewable energy credits (RECs), or other mitigation strategies. To estimate BAU emission projections from 2019 to 2050, the 2019 eGRID emission factor was held constant. This is a conservative approach to calculating projections, as the grid will likely have an increasing share of renewable energy sources.

[76] EPA 2020. "Emissions & Generation Resource Integrated Database." See: https://www.epa.gov/egrid.

The State of Maryland Renewable Energy Portfolio Standard (RPS) was incorporated into the Reference Case scenario under the assumption that the standards are met through to 2050. To estimate the Reference Case emission projections from 2019 to 2050, the Maryland RPS was used to breakout the percentage of electricity consumption that would come from clean energy sources. This was then subtracted from the BAU electricity consumption projections to provide a consumption number to be multiplied by the 2019 eGRID emission factor and calculate CO_2e emissions. As the Maryland RPS currently sets a target of 50 percent renewable energy by 2030 and does not go further thereafter, it was assumed that 50 percent of Maryland electricity would come from renewable energy sources from 2030 through to 2050.

8.1.2 On-site Fuel Use

Data for building and facility natural gas, propane, stationary gasoline, and diesel fuel oil use were provided by the County for 2010 and 2018. COG multiplied on-site annual fuel use for natural gas, propane, stationary gasoline, and diesel fuel oil by emission factors specific to each fuel type taken from ICLEI's Local Government Operations Protocol to calculate GHG emissions for each fuel type.

Natural gas, propane, stationary gasoline, and diesel fuel oil use was projected through 2050 using COG population estimates for the County. Emission factors for stationary sources (i.e., on-site fuel use) do not typically vary substantially over time and were held constant through the time series.

8.2 Transportation Sector

8.2.1 On-Road and Off-Road Vehicles

Annual fuel use data for on-road motor gasoline and diesel by vehicle type were provided by the County. Annual fuel use data for gasoline and diesel off-road equipment were provided by the County for 2018 only, as this data was incorporated into the on-road fuel consumption data for 2010. Off-road equipment is included in the total vehicle fleet numbers for 2010 and broken out separately for 2018. COG estimated CO_2e emissions from on-road and off-road vehicles based on this fuel use data. COG multiplied fuel use for each fuel type by fuel-specific emission factors to calculate annual CO_2e emissions. These emission factors were taken from ICLEI's Local Government Operations Protocol.

On-road and off-road fuel use was projected for 2019 through 2050 using COG population estimates for the County.

8.2.2 Employee Commuting

Frederick County conducted an employee commute survey in 2010. A 2018 survey was not conducted, therefore, the data collected in the 2010 survey provides the basis for employee commute-related emissions for both 2010 and 2018. The 2010 survey results were used to calculate annual vehicle miles traveled (VMT), which was used to calculate an estimate for employee commute emissions ICLEI's ClearPath tool. The calculation for annual VMT is below:

Annual VMT = # of employees x (avg. distance x 2) x (230 x # of workdays/5)

The 2010 employee commute survey found that the average one-way distance to work for Frederick County employees was 18.6 miles. This was used to calculate the annual VMT for both 2010 and 2018. The number of employees and number of workdays per week for both years were based on County employee records. The 2010 survey found that the average mile per gallon (MPG) for respondent vehicles was 23.53 MPG. Annual fuel consumption was then calculated per the formula below:

Annual Fuel Consumption (In Gal.) = Annual VMT/23.53

The annual fuel consumption was then projected from 2019 to 2050 based on COG population estimates for the County. COG multiplied fuel use by the motor gasoline emission factor from ICLEI's Local Government

Operations Protocol to calculate annual CO2e emissions for each projection year. Emissions were interpolated for the years between 2010 and 2018.

8.3 Waste Sector

8.3.1 Solid Waste

Since Frederick County operates its own landfill (Reichs Ford Road Sanitary Landfill – Site B), emissions from solid waste fall into the category of Scope 1 emissions. The County provided the annual tonnage of solid waste received at the County landfill in 2010 and 2018. Since 2005, the County's landfill has transferred most of its waste to an out-of-County waste disposal facility to preserve landfill capacity. The County's landfill continues to operate at a reduced tonnage acceptance rate. It accepts waste two weeks per year. Up until calendar year 2018, the landfill had a gas-to-energy facility; however, as of 2018, it is no longer in operation. The landfill has had a comprehensive landfill gas (LFG) collection system since 1998 and this will likely be in operation until the landfill's projected end of life. The life expectancy of the landfill is currently to the year 2045.

As the County landfill only receives waste for two weeks each year, the waste tonnage received is assumed to be relatively constant. Thus, the waste emissions were calculated out to 2050 by holding 2018's waste tonnage constant. Emissions related to energy consumption at the landfill facilities is included in the buildings and energy use sector.

8.3.2 Wastewater Treatment

Frederick County owns and operates 10 wastewater treatment facilities, which serve the County's population. The Ballenger-McKinney Wastewater Treatment Plant is the largest facility with 94 percent of the total treated wastewater flow. To estimate emissions from the operation of these facilities, the County provided data for the population served by wastewater treatment facilities for 2010 and 2018. COG's Regional Wastewater Flow Forecast Model provided the daily nitrogen (N) load for the County for both inventory years.

COG projected wastewater treatment emissions for process N_2O emissions using COG population forecasts. Emissions related to energy consumption at these facilities is included in the buildings and energy use sector.

8.4 Other Sources

8.4.1 Process and Fugitive Emissions

Fugitive natural gas emissions were calculated based on the quantity of natural gas used in county operations with a default leakage rate value of 0.3 percent based on the Environmental Defense Fund (EDF) User Guide for Natural Gas Leakage Rate Modeling Tool. COG projected fugitive natural gas emissions using COG population forecasts.

Hydrofluorocarbon (HFC) emissions were calculated for two refrigerants that the County uses in its operations. These refrigerants include HFC-410a and HFC-404a. ICLEI's Local Government Operations Protocol provides the Global Warming Potential (GWP) values for these refrigerants. The fugitive gas released for these HFCs was calculated with the following equation:

$$\text{Total Annual Emissions (metric tons of HFC)} = (A - B + C - D - E) \div 1{,}000$$

A = HFC in inventory (storage) at the beginning of the year

B = HFC in inventory (storage) at the end of the year

C = Total Additions (purchases of HFCs, including HFCs in new equipment, and HFC returned to the site after off-site recycling)

D = Total Subtractions (returns to supplier, HFC taken from storage and/or equipment and disposed of, and HFC taken from storage and/or equipment and sent off-site for recycling or reclamation)

E = Change to nameplate capacity (total full charge of new equipment, and total full charge of retiring equipment)

Frederick County was able to provide detailed logs with this information for 2018 and HFCs were able to be reported for that inventory year. The assumption was made that these figures remain relatively constant, thus, the 2018 data was used for the 2010 inventory, as well as the years between 2010 and 2018, and the projections out to 2050.

9 Technical Appendix B: Mitigation Analysis Assumptions and Methods

9.1 Buildings and Energy Use Strategies

9.1.1 Renewable Energy Procurement and Planned Grid Policies

The emission reductions from the Planned Grid Policies were accounted for based on the difference between estimated electricity emissions for each year under the BAU scenario assuming the 2019 eGRID emission factor is constant through 2050 and under emission factor projections assuming Annual Energy Outlook's Reference Case scenario which assumes a cleaner electricity grid through policies like Maryland's RPS[1].

Key Assumptions

In modeling this effort, assumptions were made on timing for offsite PPAs and REC purchases. Dedicated resources will be needed to fully plan and implement this work for the County and assumptions are highly likely to change as partnerships are developed and the County's goals are finalized. Modeling work made the following assumptions on how renewable electricity procurement could proceed by the County.

- 100% renewable electricity is purchased from 2022 – 2025 as unbundled RECs as planning for the County's next electricity contract and renewable energy contracts begins.
- First PPA securing 50% renewable electricity effective 2026, when the County's existing contract ends. This and any future PPAs would seek to hedge or lower costs as compared to recent conventional electricity procurements
- Second PPA securing an additional 50% renewable electricity effective 2028.
- Due to load growth annual renewable energy credits would be needed starting in 2029 when the PPAs energy volumes would no longer fully meet the County's REC needs.
- All renewable energy generated from PPAs would be kept and used for compliance with Maryland RPS requirements, or sold and replaced with unbundled RECs by the County in order to maintain 100% renewable electricity.

9.1.2 Low-Carbon Gas

Key Assumptions

In modeling this effort, assumptions were made on both the natural gas use of the Prospect Center and the availability and costs for renewable natural gas:

- Renewable natural gas is 100% phased implemented in 2025
- The only building targeted currently is the Prospect Center, though other sites could be identified and included.

[1] U.S. Energy Information Administration. Table 54. Electric Power Projections by Electricity Market Module Region. Available at: https://www.eia.gov/outlooks/aeo/tables_ref.php

- Natural gas use for the Prospect Center was estimated based on the EUI of similar buildings in Frederick County's portfolio

9.1.3 Green Building Standards

Key Assumptions

In modeling this effort, assumptions were made on both the new construction of facilities by the County and the various costs

- Standards are fully in place so that facilities opening in 2025 adhere to the standards.
- All new construction buildings (excluding Water, wastewater, solid waste and recycling facilities) will be both efficient (50% more than conventional buildings) and fossil fuel free.
- Total new square footage based on energy use growth projections and varies between 65,000 and 85,000 square feet from 2022-2050, even if 25% of employees telework.
- Net Zero building construction costs an estimated $7.50/sq. ft. or 5% increase compared to conventional construction

9.1.4 Utility Bill Management Database and Building Electrification

Key Assumptions

In modeling this effort, assumptions were made across the three energy conservation measures and their associated costs:

- 15-year measure life for HVAC and lighting equipment. Following the end of life, measures are reinstalled.
- LED retrofits will result in 35% lighting electricity savings.
- HVAC retrofits, including boilers, chillers, and heat pumps, will results in 10-15% savings for HVAC electricity and natural gas.
- HVAC controls will result in 10% savings from building automation systems and 1-2% savings from energy information systems.
- Whole-building energy use data (provided by Frederick County from ENERGY STAR Portfolio Manager) are apportioned to lighting and HVAC end-uses based on the Commercial Buildings Energy Consumption Survey (CBECS).
- Buildings over 10,000 square feet are prioritized in this strategy as outlined in
- Table 32 Below.
- Costs are estimated at $1.79/sq. ft. for LED upgrades, $7.99/sq. ft. for HVAC equipment upgrades and $3.00/sq. ft. for HVAC controls.

Table 32: Facility List with ECM and Electrification Measures

		Eligibility for Additional Energy Conservation Measures (Y=Eligible, N=Not Eligible, C=Already Completed)			
Site name	**Occupant/Use**	**LED Lighting**	**HVAC Retrofits**	**HVAC Controls**	**Electrification**
30 N. Market Street	Multiple occupants/uses	Y	N	C	Y
300 Scholls Lane	DFRS Logistics Warehouse	Y	N	Y	Y
118 N. Market St.	Multiple occupants/uses	Y	N	Y	Y
Adult Detention Center Complex	Multiple occupants/uses	C	Y	Y	N
Work Release	Multiple occupants/uses	Y	C	Y	Y
Animal Control	Animal Shelter	Y	N	C	Y
Brunswick Library	Branch Library	Y	Y	Y	N
Bourne Building	Multiple occupants/uses	Y	Y	Y	N
C Burr Artz Public Library	Main Library	C	C	Y	N
*Citizens Care and Rehabilitation Center	Multiple occupants/uses	Y	Y	C	N
Courthouse Complex	Multiple occupants/uses	C	C	Y	N
Emmitsburg Comm. Center	Multiple occupants/uses	C	C	Y	Y
Extension Service Bldg.	MD Extension Service	Y	C	Y	N
Family Partnership	Head Start (1), Family Partnership	Y	N	Y	Y
401 Sagner Avenue	Multiple occupants/uses	C	Y	Y	N
Health Department	Multiple occupants/uses	Y	Y	Y	Y
Highway/Fleet Complex	Administration	Y	N	Y	Y
Highway/Fleet Complex	Garages-Sheds	Y	N	Y	Y
Highway/Fleet Complex	Sign Shop Equip Bay, Tree Crew	Y	N	Y	Y
Law Enforcement Center	Sheriff Law Enforcement	C	C	Y	Y
Law Enforcement Center	State of Maryland	C	C	Y	Y

		Eligibility for Additional Energy Conservation Measures (Y=Eligible, N=Not Eligible, C=Already Completed)			
Site name	**Occupant/Use**	**LED Lighting**	**HVAC Retrofits**	**HVAC Controls**	**Electrification**
Middletown Fire Station Co. 7	DFRS	Y	N	Y	Y
Public Safety Training Facility	Fire/Rescue Services Division	C	C	C	Y
Public Safety Training Facility	Fire/Rescue Services Division Annex	C	C	C	Y
Scott Key Center	Day Program & supported employment	C	N	Y	Y
Frederick Senior Center	Senior Center	Y	C	Y	N
Spring Ridge Station # 33	0	Y	N	Y	Y
Thurmont Library	Regional Library	Y	Y	C	N
Urbana Library/Senior Center	Multiple occupants	Y	N	Y	Y
Walkersville Library	Branch Library	Y	Y	Y	N
Westview Fire Station # 31	Multiple occupants	Y	C	C	Y
Winchester Hall	Multiple occupants	C	Y	Y	Y
Monroe Center	Workforce Services	Y	Y	Y	N
Tilco Drive Warehouse	Unit A	Y	Y	Y	N
Tilco Drive Warehouse	Unit B	Y	Y	Y	N
Tilco Drive Warehouse	Unit C	Y	Y	Y	N
Prospect Center		Y	Y	Y	N

9.1.5 Building Electrification

Key Assumptions

In modeling this effort, assumptions were made about space and water heating equipment, their costs and efficiencies:

- Electrification of space heating is covered by heat pumps, including variable refrigerant flow (VRF) systems.
- Electrification of water heating is met via heat pump water heaters.
- Average, conservative efficiency gain of 18% when end use is electrified.
- Measure life of 15 years, with like-for-like replacements on burnout.
- Buildings over 10,000 square feet are prioritized in this strategy as outlined in
- Table 32 above.

9.2 Transportation Strategies

9.2.1 Fleet Electrification

Methodology

To conduct a lifecycle greenhouse gas emission analysis ICF calculated the emissions associated with both the displaced ICE vehicles and electricity needed to power the EVs replacing them. For the ICE vehicles ICF used the Argonne National Laboratory Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies (GREET) Model emission factors per gallon for diesel and gasoline. For regionalized electricity emission factors ICF used the electricity emission factors from the eGRID data for the Reliability First Corporation West (RFCW) subregion.

To monetize the economic and social cost of GHG emissions, ICF used the global mean value ($51.80) of the social cost of carbon emissions per metric ton. This value is based on findings by the Interagency Working Group on Social Cost of Carbon, led by several departments and offices within the United States Government.[2] Per the ICF and Ulupono Initiative report where this value has been sourced, this cost of carbon accounts for global impacts of GHG emissions, not just local impacts.[3]

Key Assumptions

- The County provided fleet data for 876 active, on-road vehicles. This evaluation assesses all on-road light-, medium-, and heavy-duty vehicles for electrification. Most vehicle information has been provided by the County, but some assumptions apply to these vehicles. 242 ICE vehicles are recommended for initial conversion to EVs over the next lifecycle replacement cycle, which was then repeated three times through 2050 for a total potential of 726 ICE vehicles being electrified by 2050.The fleet assessment only analyzes the current fleet and the lifecycle of the replacement vehicles; it does not consider fleet growth or adjustments other than electrification.
- Off-road vehicles are not included in the fleet assessment, per the County's request.
- EVs are only recommended when the total cost of ownership of an EV is within 5% or lower than the TCO of an equivalent ICE vehicle.
- Currently assuming County adopts 100% of the (current) electrification recommendations, and then repeats that electrification cycle two additional times before 2050. More aggressive electrification possibilities may be available after 2035, including 100% on-road fleet electrification by 2050. Instead, by repeating the current fleet electrification cycle, the on-road fleet electrification modeled will be approximately 85% electric in 2050.
- Gasoline, diesel, and electricity prices remain stable throughout the TCO timeframe. The County provided pricing for gasoline and diesel fuel, and assumptions were used for electricity pricing.
- Where County fleet data is unavailable, standard values are assumed. Standard values are derived from AFLEET and applied by vehicle type.

[2] Interagency Working Group. 2020. "Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866." Interagency Working Group on Social Cost of Carbon, United States Government. Retrieved from: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf

[3] ICF and Ulupono Initiative. 2021. "The Costs of the Vehicle Economy in Hawaii." Retrieved from: https://ulupono.com/media/8d8c251cc658751/final-report-costs-of-vehicle-economy-in-hawaii-01-26-21.pdf

- Further discussions with the County may refine the electrification list for the next 12 years, and could result in delayed savings though 2030 or even higher savings through 2050.

9.2.2 Hybrid Replacement Program

Key Assumptions

- Assumes an annual fleet turnover rate of 5%
- Hybrid vehicles reduce emissions by 45% and efficiency savings will remain constant[4]
- All gasoline passenger vehicles have an equivalent HEV model capable of completing their intended tasks

9.2.3 Diesel to Biodiesel Conversion

Key Assumptions

- B20 burns as cleanly as diesel in 2010 and newer vehicles.
- B20 burns 15% cleaner than pure diesel fuel.
- B20 prices will remain favorable compared to diesel.
- Conditions will remain favorable for B20 use year-round. In winter months, if the County is unable to obtain a B20 blend that is compatible with the regional climate, the County should switch to a biodiesel blend of 5% (B5). As a result, ICF modeled B20 with an average 15% emission savings annually for biodiesel.
- All diesel vehicles not recommended for electrification will be able to use B20.

9.2.4 Telecommuting

Key Assumptions

- 25% of employees will telecommute full-time starting in 2022

9.3 Waste Strategies

9.3.1 Increase County Waste Diversion

Key Assumptions

- Current County waste-related GHG emissions stem from direct methane emissions at the County-operated landfill.
- Current County facility waste generation and composition information is currently not available.
- **Expand food composting:** Upfront costs for this action assume $100,000 for initial consultant support and 0.5 FTE. We assume ongoing program costs of 0.25 FTE/year.
- **Recover edible food:** Upfront costs assume $15,000 for initial consultant support, and 0.14 FTE for program planning and protocol development. Ongoing costs to continue partnership with food rescue organizations estimated at 0.2 FTE/year.

[4] Emissions reduction of 45% is assumed based on the U.S. Department of Energy's "Emissions from Electric Vehicles" for Maryland. Retrieved from: https://afdc.energy.gov/vehicles/electric_emissions.html

- **Standardize waste bins & signage at County facilities:** Upfront costs assume $13,000 in materials/signage costs and 0.05 FTE for staff training. Assume 0.05 FTE in annual staff training and management.

9.3.2 Reduce County Employee Waste Generation

Key Assumptions

- Current County facility waste generation and composition information is currently not available.
- No City costs other than FTE. Based on Redmond action to increase opportunities for sort and drop-off of reuse and recyclable materials.
- Assume primarily staff time but potential for consulting group to provide waste reduction plan, $5,000 to $10,000
- Assume $10,000 for offices to go digital where they can. Could be lower because many buildings/departments will have scanners and scanning/filing software.

9.3.3 Sustainable Purchasing and Procurement

Key Assumptions

- Assume 0.12 FTE for policy development.
- Ongoing costs consist of 0.01 FTE, with an assumption that costs for environmentally friendly purchases are cost neutral to traditional products; however, prices will vary by product.