Baltimore Climate Action Plan

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Adopted by the Baltimore Climate Action Plan Advisory Committee
July 24, 2012

Adopted by the Baltimore Commission on Sustainability
October 24, 2012

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Mayor's Message

We are pleased to release the City of Baltimore's Climate Action Plan (CAP), adopted by the Planning Commission on November 29, 2012. The CAP represents our commitment to being a leader in sustainability, and improving the environment of our City. The CAP contains feasible measures to help our City reduce our greenhouse gas emissions and curb the effects of climate change on our city.

In recent years, the City has made strides in saving energy. We have worked to modernize city-owned buildings, found ways to reduce energy use with new lighting fixtures, the installation of a solar array at Back River Wastewater Treatment plant, and building envelope upgrades. We have also worked to help residents save energy with programs such as the innovative Baltimore Energy Challenge, and expanded weatherization services.

The CAP calls for these programs to continue, while also developing new programs and strategies to help reach our goal of a 15% reduction in greenhouse gas emissions by 2020. In order to reach this goal, through the CAP, we will promote renewable energy generation, and energy retrofits, waste diversion, and water efficiency.

CAP measures will help citizens save energy and money, as well as encourage the use of sustainable modes of transit, high density urban land-use, and increased tree plantings. Overall, as it is implemented, the CAP will assist in our efforts to grow Baltimore by 10,000 families in the next 10 years. As we advance this plan, we will demonstrate awareness and engagement with our residents, as well as measurable progress in greenhouse gas emissions reductions.

While we as a City alone cannot change the course of world climate patterns, we must do our part. The City of Baltimore's Climate Action plan is our promise to take action, reduce our greenhouse gas emissions, increase our quality of life, and grow Baltimore.

Thank you.

Stephanie Rawlings-Blake, Mayor

Executive Summary

The threat of climate change impacts - increased temperatures, more extreme heat days, changing precipitation patterns, and excessive cooling power demand- are becoming a reality for the City of Baltimore. The long-term effects of climate change are still unknown, but we have increased knowledge of what hazards and risks the City faces if greenhouse gas emissions mitigation is not addressed.

In 2009, the City of Baltimore adopted its Sustainability Plan. The Pollution Prevention chapter of the Sustainability Plan clearly laid forth a goal of reducing greenhouse gas emissions by 15% by 2015. The strategies associated with this goal were to create a comprehensive Climate Action Plan, and to then strategically implement the Climate Action Plan.

In 2012, the Baltimore Office of Sustainability, utilizing federal American Recovery and Reinvestment Act funding, embarked on a process to create a Climate Action Plan for the City of Baltimore. The process included the creation of a 22 member Climate Action Plan Advisory Committee, as well as working groups for Building Energy, Land Use & Transportation, Growing a Green City, and Adaptation. These working groups developed emission reduction goals and strategies that are relevant, and feasible to implement within the City.

The City of Baltimore is committed to taking action to mitigate global climate change. Baltimore's greenhouse gas emissions for our baseline year 2010 were 7,579,144 metric tons (MT) CO2e/yr and will rise to 7,838,996 MT CO2e/yr by 2020 without action. The Climate Action Plan outlines how the City will reduce greenhouse gas emissions by 15% below 2010 levels citywide by 2020.

The Climate Action Plan for the City of Baltimore provides residents, businesses, and City government with a framework for achieving the City's greenhouse gas emissions reduction goals. The framework includes sections on Energy Savings & Supply, Land Use & Transportation, and Growing a Green City. Buildings in Baltimore contribute 79% of our greenhouse gas emissions. The Energy Savings & Supply chapter addresses this through a total of 17 strategies geared to mitigate emissions from our City's residential, commercial and industrial building sectors.

It is important to note that the Climate Action Plan also accounts for strategies contained within the Sustainability Plan to help achieve our reduction goals. In order to reach our 15% reduction by 2020, the City will need to not only implement strategies laid forth in the Climate Action Plan, but also continue to implement strategies from the Sustainability Plan.

Key examples of mitigation strategies from the Climate Action Plan are:

Energy Savings & Supply
- Disclose residential energy bills and energy efficiency improvements at the beginning of the sale or rental process
- Benchmark and disclose energy performance and improvements of city –owned and privately-owned commercial, industrial and institutional buildings
- Retrofit Baltimore's street lights for more efficient energy usage
- Conduct outreach for solar installations, to achieve 30 MW of PV installed in total, across all sectors (government, commercial, institutional, multifamily, and residential) by 2020
- Promote cool roof installations and other roofing technologies

Land Use & Transportation
- Create high-quality pedestrian- and transit-oriented neighborhoods
- Promote establishment of qualified bike commute reimbursement programs
- Provide alternatives to monthly parking passes
- Develop a pedestrian master plan

Growing A Green City
- Develop a comprehensive recycling plan
- Reduce construction and demolition waste
- Repair water supply infrastructure
- Increase the number of trees planted

Reducing the City of Baltimore's greenhouse gas emissions by 15% by 2020 will be a challenging. The Commission on Sustainability has created a Climate Committee to assist the Office of Sustainability in monitoring and implementing the strategies.
It is far more costly to ignore climate change and its effects on Baltimore, than to take action to mitigate its impacts.

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Chapter 1

Introduction

Baltimore row houses (Source: Flickr User Sidereal)

Purpose of the Climate Action Plan

The City of Baltimore has developed a Climate Action Plan (CAP) to reduce Baltimore's greenhouse gas (GHG) emissions through a range of strategies targeted at reducing the amount of fossil fuel needed for everyday living. A CAP does much more, however, than just reduce greenhouse gas emissions. If implemented successfully, the CAP will help make Baltimore a more attractive place for existing and future residents, employers and visitors. The strategies that reduce greenhouse gas emissions also increase the energy efficiency of buildings resulting in lower energy and water bills; promote low cost transit options amidst rising fuel costs; promote safer streets for pedestrians and cyclists; improve the public realm and air quality; increase recycling and re-use of materials; green the city through more tree plantings, and cultivated, clean vacant lots; support local jobs; and promote mixed-use and mixed income neighborhoods close to public transit. These outcomes of the CAP in addition to outcomes of the Baltimore Sustainability Plan will create a future for Baltimore that includes:

- An emphasis on energy cost efficiency measures, education and outreach about energy cost saving rebates, re-investments and incentives, photovoltaic and solar hot water installations on homes and businesses and new buildings that use less energy than conventional buildings;
- A business and residential community committed to a more sustainable way of working and living;
- Incentives to encourage commuters to use alternative means to get to work other than driving alone;
- Communities that support transit oriented development and allow neighborhood commercial districts to flourish;
- Streets that support bicycling and walking for everyday needs and for the daily commute;
- Neighborhoods with clean water and shade for walking through green urban design and landscaping; and
- Water usage that sustains local water supplies.

The CAP is a document that lays out strategies to reduce GHG emissions associated with the activities of a city including businesses, institutions, local government and residents. The Baltimore City CAP is designed to meet these objectives by:

- Informing and inspiring meaningful, cost-effective and feasible means of meeting targets for emissions reductions;
- Enhancing, strengthening and complementing Baltimore Sustainability Plan actions already underway and planned for future implementation;
- Outlining implementation actions for each proposed measure including responsibilities and time frames; and
- Identifying procedures for monitoring progress made toward achievement of GHG emissions reduction targets.

Baltimore's initiative to develop a CAP distinguishes the city as a true national sustainability leader. CAPs are the primary tool for jurisdictions across the world to reduce their GHG emissions. Across the U.S., CAPs have been adopted at state, county, city and university/campus levels. Although efforts are underway at the global, national and state level, local actions are essential to address the impacts of climate change.

Relationship to the Sustainability Plan

The City of Baltimore adopted and released the Baltimore Sustainability Plan in 2009 to help ensure that Baltimore thrives for generations to come. The Plan promotes 29 priority goals with strategies to realize a clean, healthy, efficient, green, mobile, aware and invested community. One of the primary sectors addressed by the Sustainability Plan is 'Pollution Prevention', which includes the priority Goal #1 of reducing Baltimore's greenhouse gas emissions by 15 percent by 2015. The two key strategies associated with this goal call for the creation and implementation of a Climate Action Plan (CAP) for the City of Baltimore that includes GHG emissions based targets.

The CAP provides further detail of action and implementation steps for some GHG reduction-related Sustainability Plan measures. Extensive public outreach and engagement of the Sustainability Plan process has informed the CAP development process. Many of the goals and strategies contained within the CAP relate to strategies within the Sustainability Plan. Since the key goal of the CAP is to achieve a target of emissions reduction, the CAP process also includes a quantification of anticipated GHG emission reduction savings that may result from the implementation of goals within the Sustainability Plan.

Relationship to Other State and County Documents

In 2009, Maryland Governor O'Malley and the Maryland General Assembly passed the Greenhouse Gas Emissions Reduction Act of 2009 (GGRA). The law requires the state to develop and implement a plan to reduce greenhouse gas emissions by 25 percent from a 2006 baseline by 2020. (The 2011 GGRA Draft Plan was released in March 2012 with the final plan to be completed in December 2012). To provide a sense of scale in the GHG reduction challenge at the state level, the state of Maryland's GHG emissions are roughly equivalent to the GHG emissions of Norway and Sweden combined. Under the GGRA, by 2015, the Maryland Department of the Environment is required to provide an emissions action update with a decision required by the legislature in 2016 on whether to continue, adjust or eliminate the 2020 target. Also, Maryland's EMPOWER program requires utilities to offer rebate and incentive programs to help reduce the state's electricity usage by 15 percent by 2015. Many of the rebates offered to Baltimore City electricity consumers stem from the EMPOWER requirements. Locally, neighboring Baltimore County prepared a GHG inventory in 2008 that calls for a 10 percent reduction by 2012, providing the county and local officials with the ability to set local GHG emissions reduction strategies.

By creating the CAP, the City of Baltimore is doing its part to mitigate climate change, enhance the state GHG reduction goal as well as provide numerous economic, health and social co-benefits for Baltimore's residents, businesses, government and institutions.

Baltimore City Action

Baltimore City has an ever-growing record of meaningful programs and actions which are promoting sustainability of the city's natural, social and financial capital. Since 2007, the Baltimore City Office of Sustainability has been developing and advocating for programs, policies and actions by government, citizens, businesses and institutions that improve the long-term environmental, social and economic viability of the city. In addition to overseeing and tracking the implementation of the Baltimore Sustainability Plan, the Office of Sustainability integrates sustainability into city government operations and develops partnerships with grassroots and community-based organizations.

The Baltimore Sustainability Plan was adopted in 2009. The 2010 and 2011 Annual Reports document progress.

Key city-wide sustainability actions and achievements in Baltimore

- Creation and launch of the Baltimore City Green Building Standards that require Leadership in Energy and Environmental Design (LEED) Silver certification or equivalent for all commercial and multifamily residential buildings over 10,000 square feet.
- Implementation of the Baltimore Energy Challenge (BEC) to promote energy cost savings for low income residents by distributing energy savings kits to more than 1,400 participating households in 19 neighborhoods.
- Leadership, support and implementation of the Baltimore City Sustainability Plan's 29 priority goals across thematic areas including cleanliness, pollution prevention, resource conservation, greening, transportation, education & awareness and green economy.
- Implementation of the weatherization assistance program, which contributed improvements to more than 1,000 homes in the city.
- Providing grants for students at 74 different schools to improve the environmental performance of their schools.
- Teaming with Blue Water Baltimore to provide education and outreach for implementing water saving tools such as rain barrels and water audits.
- Installation of a 4,200-panel solar photovoltaic system that is spread over 5 acres on the grounds of the Back River wastewater treatment plant and capable of generating 1MW of power.
- Growing the tree canopy by a net average increase of at least 3,000 trees per year since 2009.
- Partnering with Johns Hopkins University to undertake the Climate Showcase Program to provide energy and GHG-reducing options for the city's non-profit sector.
- Teaming with the Baltimore City Department of Public Works and Bureau of Water and Wastewater to capture methane released from city landfills and wastewater treatment facilities.

Climate Change Science

Scientists from the United Nations Intergovernmental Panel on Climate Change (IPCC) who conduct research on climate-related topics and publish in peer-reviewed scholarly journals agree, in the largest consensus scientists have ever assembled from around the world, that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [human-generated] greenhouse gas concentrations." The IPCC defines "very likely" as greater than 90 percent probability of occurrence[1].

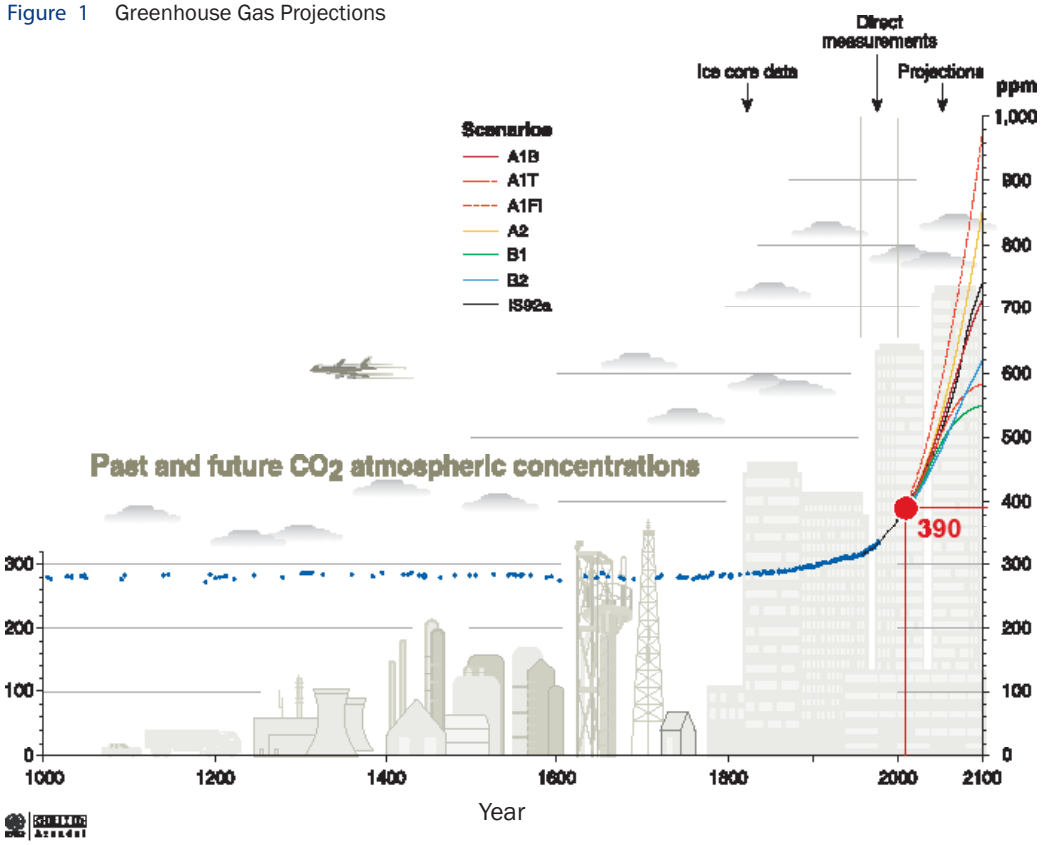
Due largely to the combustion of fossil fuels, atmospheric concentrations of carbon dioxide (CO_2), the principal human-generated greenhouse gas, have been rising and are at a level unequaled for at least the last 800,000 years[2]. Greenhouse gases from human activities, such as the burning of fossil fuels for use in buildings and transportation, and methane production from agricultural practices, are trapping more of the sun's heat in the earth's atmosphere and warming the earth. Over the last century, average global temperatures rose by more than 1°F, and the arctic warmed about twice as much[3], with predictions for continued temperature increases in the coming years[4].

Trend projections, shown in Figure 1, indicate that atmospheric concentrations of GHG emissions will continue to increase throughout this century. If these projections become reality, climate change will threaten our economic well-being, public health and environment.

In its fourth assessment of climate change, the IPCC provides a comprehensive overview of the impacts of climate change. This report describes potential global emission scenarios for the coming century. These scenarios vary from a best-case scenario characterized by low population growth, clean technologies, and low GHG emissions to a worst-case scenario where high population and fossil-fuel dependence result in extreme levels of GHG emissions. While scientists indicate that some degree of climate change is inevitable, they also agree that atmospheric GHG concentrations need to be stabilized in order to avoid the most serious impacts.

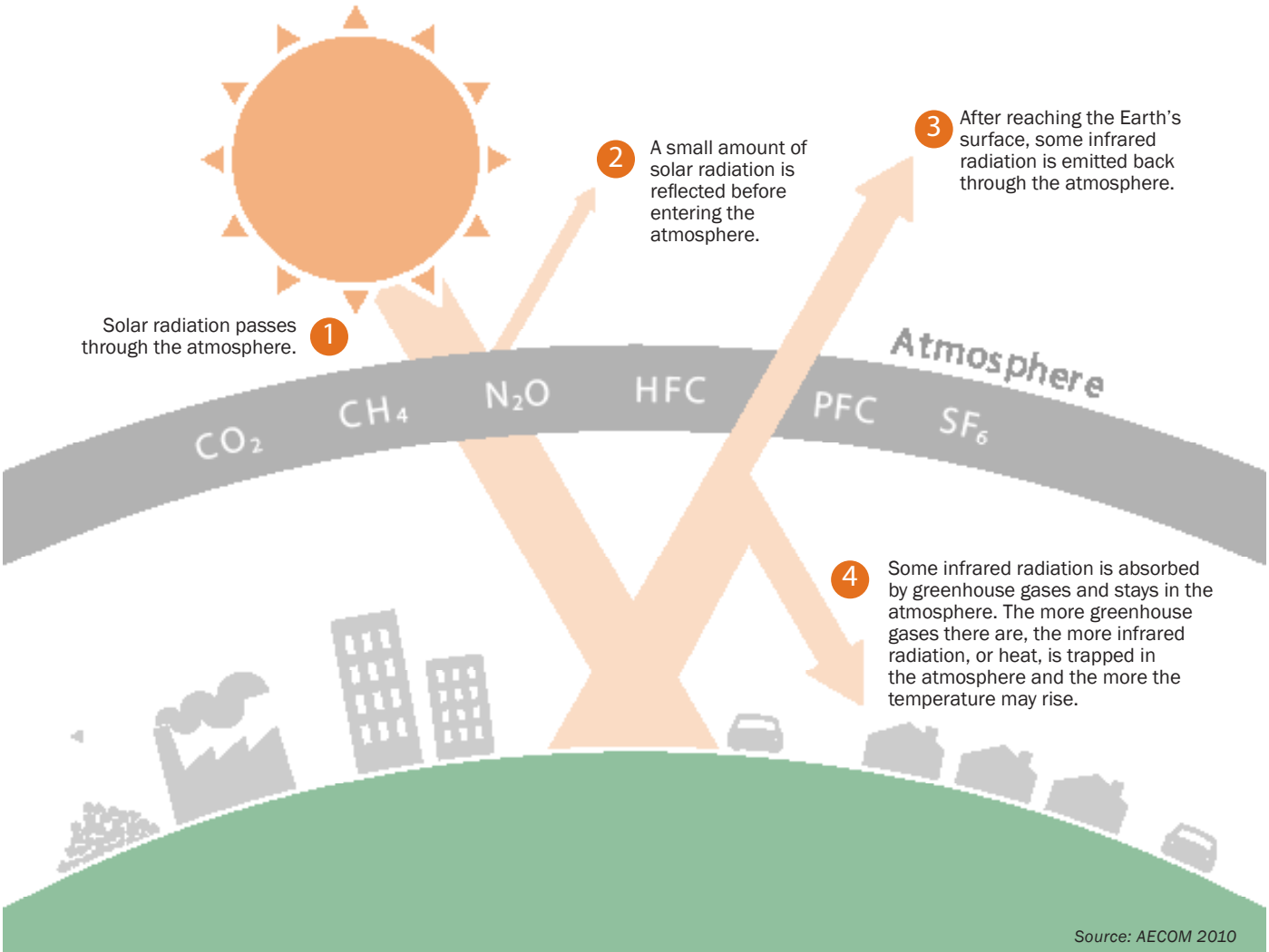
1 *Climate Change 2007: The Physical Science Basis, IPCC, 2007. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*
2 *Climate Change 101: Understanding and Responding to Global Climate Change, Pew Center, Updated January 2011.*
3 *Smith, T.M., R.W. Reynolds, T.C. Peterson and J. Lawrence, 2008: Improvements to NOAA's historical merged land-ocean surface temperature. Journal of Climate 2009.*
4 *Climate Change 101: Understanding and Responding to Global Climate Change, Pew Center, Updated January 2011.*

Figure 1 Greenhouse Gas Projections



Source: Philippe Rekacewicz, Emmanuelle Bournay, UNEP/ GRID-Arendal. Scenarios refer to IPCC-developed emissions projections based on changes in economic growth,population, and technology, detailed at http:// www.ipcc-data.org/ddc_co2. html.

Figure 2 The Greenhouse Effect and Greenhouse Gases



Source: AECOM 2010

Although there are dozens of GHGs, the Intergovernmental Panel on Climate Change (IPCC) identifies six primary GHG compounds (shown in Figure 2), including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) as the predominant GHGs found in non-industrial processes. Each type of GHG has a different capacity for trapping heat and, therefore, GHG emissions are "equalized" by their global warming potential (GWP) and are reported in this CAP in "Metric Tons of CO_2 equivalents" (MT CO_2e). For example, 1 ton of CH_4 has the same contribution to the greenhouse effect as approximately 21 tons of CO_2 on a 100-year timescale and would, therefore, have a CO_2e of 21 tons. Listed in Table 1 are the primary GHGs, along with their symbols, GWP, and common human-generated sources.

Table 1 Primary Greenhouse Gases

Symbol	Name	GWP (MT CO_2e)	Human-generated Sources
CO_2	Carbon Dioxide	1	Fossil fuel combustion, forest clearing, cement production
CH_4	Methane	21	Fossil fuel combustion, landfills, livestock, cultivation
N_2O	Nitrous Oxide	310	Fossil fuel combustion, nylon production
HFC	Hydrofluorocarbons	140–14,800	Refrigeration gases, semiconductor manufacturing
PFC	Perfluorocarbons	6,500–12,200	Aluminum production, semiconductor manufacturing
SF_6	Sulfur Hexafluoride	23,900	Electrical transmissions and distribution system, circuit breakers

Local Effects of Climate Change

Scientists and the general public are already seeing the local effects of climate change around the world. While models of the potential impact of climate change have primarily been developed at global and regional scales, much uncertainty still exists about the extent of the changes that could be felt due to the incredibly complex interactions at play, particularly at the city level. Climate change is beginning to impact Baltimore residents, businesses and visitors through events such as higher, prolonged summer temperatures, which are increasing cooling load demands. In Maryland and likely within Baltimore the following changes may be seen[1] (see Chapter 4: Climate Adaptation for more detail):

- Extreme temperatures, elevated and prolonged urban heat island effect
- Excessive demand for cooling power (e.g. air conditioning) which can increase the likelihood of power brownouts and blackouts
- Fluctuations between flooding from intense storms and droughts
- Sea-level rise
- Changes in ecosystems, and the decline or loss of some species and the increase of others
- Increased frequency of severe snow storms and severe winter weather events
- Extended heat waves with a threefold increase in the number of days exceeding 90°F, by 2050
- Increased incidence of asthma and other respiratory ailments
- High daily temperatures without cooling off much at night

All of these changes have the capacity to impact the economy, environment, public health and lifestyle of people throughout Baltimore. Some of the potential economic impacts of climate change include strains on the health care system and labor market due to health-related illnesses and deaths, changes in energy costs due to regional shifts in cooling and heating demand and recreation and tourism declines. More extreme weather events, including a greater number of extremely hot days, can lead to heat-related health issues, especially for those who cannot access cool areas. Increased precipitation can cause public health impacts. A study from the Johns Hopkins School of Public Health shows a positive correlation between higher-than-average precipitation events and outbreaks of waterborne diseases[2]. Greater intensity runoff events can increase particulate and chemical concentrations in aquifers for drinking water.

However, not all impacts due to climate change may yield negative impacts. Baltimore City's water-supply system could benefit from greater winter-spring precipitation that would increase the likelihood that reservoirs will be full heading into the drier summer periods, resulting in protection from water-supply shortages for areas served by the reservoirs.

Scope and Content

The remainder of this document outlines the CAP development process and GHG reduction measures and actions that will help the city achieve its GHG reduction target.

Chapter 2: The Planning Process This chapter outlines the main steps that were taken to develop the CAP, including creation of the CAP Advisory Committee, the update of the 2010 baseline GHG inventory, projections of future emissions anticipated in 2020 in a business-as-usual scenario, and an explanation of the methodology that was used for identifying and developing the measures.

Chapter 3: Greenhouse Gas Reduction Measures This chapter addresses the three main Action Areas and includes: Energy Savings & Supply, Land Use & Transportation, and Growing a Green City. For each Action Area, the CAP identifies specific measures, and for each measure outlines estimated GHG reduction, progress indicators, and actions with associated time frames and key responsible parties for implementation.

Chapter 4: Climate Adaptation This chapter explores ways that Baltimore can best manage risks and protect vulnerable populations from the anticipated impacts of climate change. Chapter 4 highlights the GHG emission reduction measures that also have adaptation impacts and identifies priority strategies for the All Hazards Mitigation Plan (AHMP) and other future adaptation planning strategies. Key actions for harmonizing with state and federal requirements will also be identified along with a presentation of maps which prioritize vulnerable populations for strategy focus.

Chapter 5: Monitor and Evaluate This chapter looks at how progress on CAP implementation will be measured and evaluated and discusses the mechanisms for evolving the CAP over time to ensure that it remains relevant and feasible while becoming increasingly integrated into government decision-making.

Appendices Detailed appendices provide information on acronym definitions, the CAP Advisory Committee members, Town Hall meeting, quantification details, and climate adaptation activities.

1 *Impacts are drawn from Climate Change Impacts on Maryland and the Cost of Inaction (2008). Center for Integrative Environmental Research; Comprehensive Assessment of Climate Change Impacts in Maryland (2008). Maryland Commission on Climate Change.; Maryland's Plan to Reduce GHG Emissions (2011) Maryland Department of Environment.*

2 *Curriero, F.C., Patz, J.A., Rose, J.B., Lele, S. 2001. The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948–1994. American Journal of Public Health 91(8): 1194-1199.*

Chapter 2

The Planning Process

Climate Action Plan Town Hall meeting (Source: AECOM)

The Planning Process

Baltimore City has developed medium-term strategies (by 2020) to reduce its contribution to climate change through preparation of the Baltimore CAP. By reducing GHG emissions generated from community-wide activities including energy, transportation, water, waste and land use, the city aims to achieve a 15 percent reduction of GHG emissions by 2020.

The CAP addresses activities the city can influence, such as emissions generated from city-owned and operated assets, homes, businesses, vehicles and industrial activities within the geographical boundaries of the city. However, activities such as Port of Baltimore cargo ship operations and vehicles moving through Baltimore on interstate highways are beyond the influence of city jurisdiction and thus are not included within the scope of the CAP.

The city's development of a CAP to reduce GHG emissions parallels climate change planning processes being followed by communities nationwide. In addition the CAP identifies key considerations that will help prepare the city for the eventual impacts of climate change. This process includes:

1. Creating an Advisory Committee - convening a team of key advisors from community organizations, city, county and state entities to develop core recommendations of the CAP;
2. Completing GHG emissions inventory and projections of future emissions;
3. Identifying a community-wide GHG reduction target;
4. Developing strategies and measures to meet the reduction target; and
5. Identifying a monitoring and evaluation strategy for the reduction measures.

Creating the Advisory Committee & Working Groups

Building upon the key working group process used to construct the Sustainability Plan, the Baltimore Office of Sustainability (BOS) convened the CAP Advisory Committee to develop the core content of the CAP and its recommendations through:

- Serving as a sounding board during plan development to ensure ideas are feasible and relevant to Baltimore,
- Offering expertise and providing context specific input to ensure the plan is forward-thinking and innovative and is linked into other city and regional sustainability initiatives, and
- Serving as ambassadors to respective communities to ensure that Baltimore residents and businesses are engaged and motivated throughout the process.

The Advisory Committee was composed of approximately 30 experts and decision-makers representing community, city, county and state entities most relevant to implementation of the CAP including: City of Baltimore Departments of Planning, General Services, Transportation, Recreation and Parks, Fire, Health, Baltimore Housing; the Baltimore Commission on Sustainability; the Waterfront Partnership; Constellation Energy; and resident representatives. (See Appendix B for a full list of the Advisory Committee members.) The Committee met as an entire group on four occasions over a span of six months to provide guidance and feedback to the BOS and the consultant team regarding priorities and key considerations for strategy development. In between each Advisory Committee meeting, the Committee met in smaller working groups organized by four areas (building energy; land use and transportation; water, waste and green infrastructure; and climate adaptation). Each working group reviewed proposed measures, generated new measures, eliminated ideas deemed not feasible and prioritized appropriate measures based on feasibility and applicability to Baltimore.

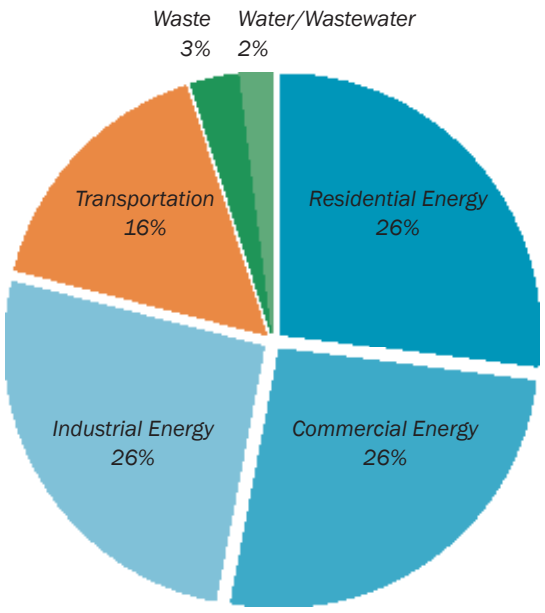
The first Advisory Committee Meeting (Introduction to CAP Process, January 10, 2012) kicked off by introducing the Committee to the CAP development process. The Committee was also informed about baseline GHG inventory findings for Baltimore, provided guidance on identifying existing actions underway that can contribute to GHG emissions reductions and formed working groups to address key sectors such as building energy; waste, water and green infrastructure; land use and transportation; and climate adaptation. Meeting in working groups during the second half of the session, each group reviewed a list of existing measures from the Sustainability Plan, best practices from other CAPs and shared input on which measures could be enhanced to promote GHG emissions reductions. In addition, each group shared ideas on new strategies that could reduce GHG emissions.

In order to ensure that the CAP comprehensively captured existing activities from across the city that may contribute to GHG emissions reductions, each working group reviewed a gap analysis table of existing Baltimore measures and policies currently identified through the Sustainability Plan and/or being implemented that can contribute to GHG emissions reductions. Building upon this existing list, the working groups identified additional actions and measures not yet captured in the gap analysis.

Preparing the GHG Emissions Inventory and Projections

The baseline greenhouse gas inventory and business-as-usual projection provided the city and the Advisory Committee with an understanding of both where Baltimore's emissions of GHGs are coming from and projection of how and where emissions will grow by 2020. This information enabled the city and Advisory Committee to develop strategies that can most effectively target sectors and slow GHG emissions. During the second Advisory Committee meeting (Review of Inventory and Development of Proposed GHG Reduction Measures, February 21, 2012) the Committee reviewed the City of Baltimore 2010 Baseline GHG Emissions Inventory, examined the differences between voluntary and mandatory measures, discussed how to set a city-wide emissions reduction target and presented proposed GHG reduction measures developed by the working groups on building energy and land use and transportation. The meeting also included a presentation of preliminary GHG emissions quantifications of relevant Sustainability Plan measures reviewed by the Committee at the first Advisory Committee meeting.

Figure 3 City of Baltimore 2010 Baseline GHG Emissions Inventory



(Source: Baltimore City Council 2010, AECOM 2011)

Baseline GHG Emissions Inventory

The purpose of a GHG emissions inventory is to identify where emissions are occurring and the relative contribution of various operational activities within a jurisdiction. This baseline helped guide and focus the Advisory Committee and city staff to prioritize strategies within the sectors that have the largest reduction potential. An accurate inventory is necessary to understand which sectors comprise the largest portion of the GHG inventory, have the most reduction potential, and can be effectively influenced by policies and actions implemented by the city. Furthermore, the inventory provides a benchmark from which GHG reductions from CAP measures and actions can be calculated, measured and evaluated in future CAP updates.

The city prepared a 2010 baseline GHG inventory using the International Council for Local Environmental Initiatives (ICLEI) Clean Air & Climate Protection (CACP) software. The city's baseline inventory is organized by emission sectors. A "sector" is a distinct subset of a market, society (e.g., transportation, energy and water), industry or economy, whose components share similar characteristics. An emission sector may also contain sub-sectors that provide more specificity about the source of emissions (e.g., natural gas or electricity can be a sub-sector of energy consumption). The CACP software divides an inventory into basic emission sectors, including residential, commercial, and industrial energy use; transportation; and solid waste.

The consultant team performed a peer review of the 2010 Baseline GHG inventory to identify potential revisions which would enable effective CAP implementation and monitoring. The peer review examined all emission sectors with regard to emission factors, data sources and quantification methodologies and made revisions to the baseline inventory. The 2010 GHG Baseline Inventory illustrated in Figure 3 is the final inventory used for the CAP.

The final 2010 Baseline GHG Emissions Inventory shows that the energy sector is the source for approximately 79 percent of the city's emissions (residential, commercial and industrial energy combined) followed by transportation (16 percent), waste (3 percent) and water/wastewater (2 percent).

Business-as-Usual Projections

The baseline emissions inventory was used to project the city's GHG emissions in 2020 under a business-as-usual scenario, shown in Table 2. The business-as-usual scenario assumes that historical and current GHG-generating practices and trends for energy consumption, transportation, solid waste, and water consumption will continue until 2020.

The 2020 business-as-usual projections were performed using applicable and appropriate indicators for each sector. It should be noted that these projections have been developed for planning purposes, and due to the complexity of each emissions sector, are subject to change.

Assuming that the current emissions generating practices continue to occur, city-wide GHG emissions are anticipated to increase from 7,579,144 metric tons (MT) CO_2e/yr in 2010 to 7,838,996 MT CO_2e/yr in 2020. Key findings by sector provide guidance for where strategies can perhaps slow future emissions growth.

- GHG emissions from the energy sector are anticipated to increase slightly from 79.5 percent (2010) to 79.9 percent (2020).
- The transportation-related emissions are anticipated to decrease from 15.6 percent (2010) to 15.2 percent (2020).
- The waste-related emissions are anticipated to remain unchanged at 2.8 percent.
- Wastewater treatment GHG emissions are expected to remain unchanged at 1.5 percent.
- GHG emissions from the water sector are anticipated to remain unchanged at 0.7 percent.

All GHG emissions have been calculated and presented in metric tons of carbon dioxide equivalent emissions per year (MT CO_2e/yr).

Relationship of Energy to GHG Emissions

The consumption of electricity, natural gas, kerosene and heating oil within residential, commercial and industrial buildings (or facilities) generates over 79.5 percent of the city's greenhouse gas emissions community-wide. This sector presents a prime opportunity for energy efficiency actions, which can reduce utility bills and lead to long term energy cost savings and reduced risk of rising energy prices. The city government's building energy is the largest contributor of emissions within government operations and is included within the commercial energy sub-sector of the inventory.

Relationship of Transportation to GHG Emissions

This sector's emissions (15.6 percent of the total inventory) are generated by vehicle consumption of gasoline estimates. Community land use patterns have a strong impact on transportation-related GHG emissions. Where people live dictates how far they have to travel to work, shopping and other destinations, and influences whether they choose to walk, bike, take public transit or drive. If residents live close to transit stations, neighborhood-serving commercial centers or their work, they are more likely to use alternative lower-emissions travel modes than driving. The CAP addresses transportation and land use strategies as one integrated sector.

One of the primary findings of the peer review was the modification of the transportation portion of the inventory. The consultant team excluded vehicle miles travelled (VMT) that do not originate or terminate in the city as the city government cannot influence the movement of vehicles travelling along interstates (e.g., U.S. I-95) that pass through Baltimore. This revision reduced transportation emissions from 33.2 percent to approximately 15.6 percent of the inventory. The revised inventory now includes only VMT related emissions that are more closely linked with the land uses in the city and those land uses that can more feasibly be affected by measures and actions from the CAP.

Relationship of Waste, Water and Wastewater to GHG Emissions

The relatively small footprint of Baltimore's waste, water and wastewater sector (5 percent of the inventory) can be explained by the fact that most of Baltimore's waste is incinerated and converted to energy, i.e., not disposed of in a landfill. Also, methane released from landfills and some of the wastewater treatment facilities is captured and converted into energy, further contributing to maintenance of a low emissions reduction value. Considerable amounts of energy are used to pump, treat, transport, heat and cool water for consumption (potable) and wastewater. Thus, water conservation reduces energy consumption, lowers GHG emissions and protects valuable water resources.

Table 2 City of Baltimore Baseline (2010) and Projected Emissions (for 2020) by Sector and Sub Sector

SECTOR & SUBSECTOR	REVISED 2010 ACTIVITY LEVEL Amount	Units	REVISED 2010 BASELINE INVENTORY Emissions	%	PROJECTED 2020 INVENTORY Emissions	%
Energy			**6,024,557**	**79.5%**	**6,264,867**	**79.9%**
Electricity	6,814,978	MWh	3,655,351	48.2%	3,801,157	48.5%
Natural Gas	363,139,339	therms	2,369,206	31.3%	2,463,710	31.4%
Residential Energy			2,080,919	27.5%	2,163,923	27.6%
Electricity	1,892,549	MWh	1,015,107	13.4%	1,055,598	13.5%
Natural Gas	156,243,519	therms	1,065,812	14.1%	1,108,325	14.1%
Commercial Energy			1,990,610	26.3%	2,070,012	26.4%
Electricity	2,459,563	MWh	1,319,236	17.4%	1,371,858	17.5%
Natural Gas	87,781,690	therms	671,374	8.9%	698,154	8.9%
Industrial Energy			1,953,028	25.8%	2,030,931	25.9%
Electricity	2,462,865	MWh	1,321,008	17.4%	1,373,701	17.5%
Natural Gas	119,114,130	therms	632,020	8.3%	657,230	8.4%
Transportation			**1,183,046**	**15.6%**	**1,187,769**	**15.2%**
Gasoline	2,041,887,098	VMT/yr	976,217	12.9%	976,217	12.5%
Diesel	63,329,515	VMT/yr	88,432	1.2%	88,432	1.1%
Port	360,786	gallons	2,732	0.04%	2,841	0.0%
Bus	6,679,580	gallons	67,826	0.9%	70,532	0.9%
Metro-Light Rail	89,228	MWh	47,839	0.6%	49,748	0.6%
Waste Disposal	**955,651**	**tons/yr**	**209,315**	**2.8%**	**217,664**	**2.8%**
Wastewater Treatment	**114.37**	**MGD***	**110,988**	**1.5%**	**115,415**	**1.5%**
Water Delivery	**107.35**	**MGD***	**51,237**	**0.7%**	**53,281**	**0.7%**
Total Emissions			7,579,144 MT CO_2e		7,838,996 MT CO_2e	

Source: AECOM 2012
Note: Totals for Energy and Transportation in the Revised 2010 Activity Level column are not included due to inputs with varying units. See Appendix A for a list of acronym definitions.

** millions of gallons per day*

Identifying a GHG Emissions Reduction Target

Following the review of the inventory and projections, adopting an emission reduction target is a helpful step to identify the depth and extent of GHG reduction measures required. Targets are set in a number of ways and can be guided by state reduction goals, adjacent jurisdictions or to meet city aspirations. Table 3 lists major east coast localities and their respective GHG reduction targets.

In Baltimore, the majority of the city's emissions are from the building energy sector, so this is where emission reduction strategies are focused. Baltimore is fairly built-out as a city with more than half of the residential building stock representing row houses built in the 1930s and 1940s with limited new construction over the past few years. This means that the majority of the GHG reductions need to come from energy efficiency, improvements in the existing building sector through a combination of voluntary, incentive and mandate-based policies. Transportation emissions make up the next largest proportion of emissions. This area can be the hardest in which to realize reductions due to the time it takes for land use policy to take effect, or (often very expensive) transportation infrastructure improvements to be realized. Water, waste and wastewater make up a very small percentage of Baltimore's inventory therefore even significant reductions within those sectors will only have a relatively small impact.

In light of this, and having reviewed the potential reductions possible from the suite of GHG reduction measures identified by BOS and the Advisory Committee, a reduction target of 15 percent was identified.

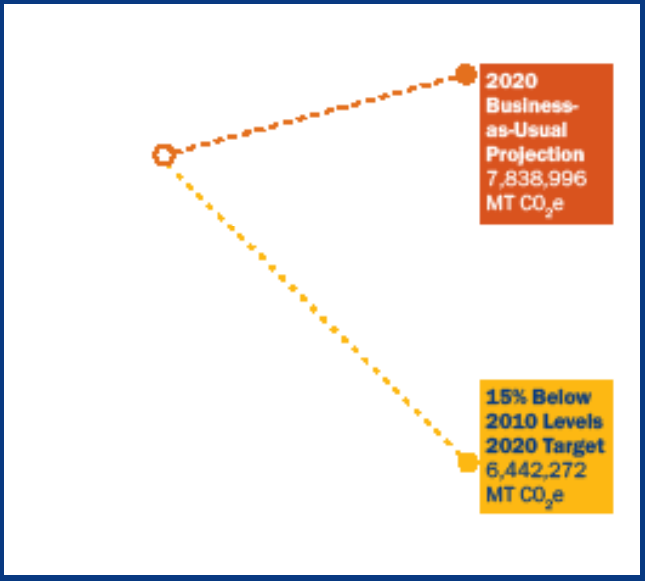
Achievement of this target will help the city see that it is possible and cost-effective to reduce GHG emissions. This target corresponds to a 2020 GHG emissions level of 6,442,272 MT CO_2e/yr, which is an absolute reduction of 1,396,724 MT CO_2e/yr in 2020. Figure 4 demonstrates the magnitude of the GHG reduction target. A target and time frame is most effective if it is aligned with the political, technical and economic realities of a local community.

Longer-term initiatives, which require a more favorable economic and fiscal climate, have been identified in the CAP and can be expanded upon once the city reaches the 2020 target, by identifying more significant reductions that look to 2030 or 2050 and build upon the successful lessons and strategies learned from CAP implementation.

Table 3 GHG Emission Targets of other East Coast Localities

	BASELINE YEAR	% REDUCTION	TARGET YEAR
City of Baltimore	2010	15	2020
State of Maryland	2006	25	2020
Washington, D.C.	2006	30	2020
New York City	2007	30	2030

Figure 4 2020 Target GHG Reduction



Other Reduction Sources

Anticipated GHG Reductions from the Baltimore Sustainability Plan

Note that the GHG emissions reductions for relevant Sustainability Plan goals and strategies have been wrapped into the CAP reduction assumptions.

It is estimated that the Sustainability Plan goals will provide 170,910 MT CO_2e reductions by 2020 in Baltimore. Reductions include implementation of the Green Building Ordinance, residential appliance upgrades through rebates, outreach and city-wide smart meter installation.

Inclusion of Federal and State GHG Reduction Measures

In addition to the measures being developed through the Advisory Committee and those integrated from the Sustainability Plan, federal and state reduction measures underway also contributed to emissions reductions for Baltimore and can comprise a significant percentage of overall predicted GHG reductions.

CAFE (Corporate Average Fuel Economy)

The CAFE standards will apply to passenger cars and light trucks manufactured in model years 2012 through 2016. They will require these vehicles to meet an estimated combined average mile per gallon (mpg) of 34.1 by 2016. Together with Environmental Protection Agency (EPA) standards, which also enable manufacturers to achieve compliance by improving the air conditioners of their vehicles, the national program overall is expected to result in improvement levels equivalent to 35.5 mpg. It is predicted that the CAFE standards will provide 165,340 MT CO_2e reductions by 2020 in Baltimore.

Renewable Portfolio Standard (RPS)

Maryland's Renewable Portfolio Standard, enacted in May 2004 and revised in 2007, 2008 and 2010 requires electricity suppliers (all utilities and competitive retail suppliers) to use renewable energy sources to generate a minimum portion of their retail sales. Beginning in 2006, electricity suppliers are required to provide percent of retail electricity sales in the state from Tier 1 renewables and 2.52.from Tier 2 renewables. The renewables requirement increases, ultimately reaching a level of 20 percent from Tier 1 renewables in 2022 and beyond, and 2.5% from Tier 2 renewables from 2006 through 2018.

Wind turbine (Source: AECOM)

Tier 1 renewables include solar, wind, qualifying biomass (excluding sawdust), methane from a landfill or waste water treatment plant, geothermal, ocean, fuel cells powered by methane or biomass, small hydroelectric plants (systems less than 30 megawatts in capacity) and poultry-litter incineration facilities connected to the Maryland distribution grid. Waste-to-energy facilities and facilities that use refuse-derived fuel that are connected to the Maryland distribution grid also qualify as Tier 1 renewables. Tier 2 includes hydroelectric power other than pump-storage generation.[1]

It is predicted that the RPS will provide 484,432 MT CO_2e reductions by 2020 in Baltimore.

Federal and state reductions measures will contribute 649,772 MT CO_2e or 42 percent towards Baltimore's reduction target.

1 *RPS Report of 2012. Maryland Public Service Commission.*

Developing Strategies & Measures to Meet Target

The development of GHG reduction measures was led by the Advisory Committee and the BOS and was informed by the baseline GHG inventory, business-as-usual projections and policies initiated by other cities. Charged with achieving an emissions reduction target of 15% by 2020, the Advisory Committee and its working groups set about the task of developing measures for reducing GHG emissions. Each working group's efforts to develop measures for the CAP were informed by (a) evaluating existing community conditions, (b) identifying emission reduction opportunities within the city, (c) reviewing best practices from other jurisdictions and organizations and (d) incorporating state and regional laws, guidelines and recommendations. After considering a wide range of potential options, measures and actions were recommended based on the following criteria:

- Is it technically feasible to implement the measure?
- Does the measure create additional community benefits (e.g., quality of life, public health) and would the community support it?
- What are the potential costs and savings of measure implementation?

Between the first and second Advisory Committee meetings, the working groups in building energy, and land use and transportation reviewed precedent policies from other cities for potential inclusion and/or modification as part of Baltimore's CAP. The working groups prepared shorter lists of proposed measures that eliminated the policies not deemed feasible for the city and included potential policies for inclusion in the CAP.

During the second Advisory Committee meeting (Review of Inventory and Development of Proposed GHG Reduction Measures, February 21, 2012), the Committee reviewed proposed measures from each working group and shared input regarding how to refine measures for feasible implementation by Baltimore's commercial and residential sectors. The outcome was a condensed shortlist of building energy and land use and transportation measures that the full Committee agreed upon as potential draft measures to be detailed and quantified for determining potential GHG emissions reductions savings.

The third Advisory Committee meeting (Develop Proposed Measures, April 2, 2012) focused on the Committee's review of proposed measures addressing the waste, water and green infrastructure sector. Also reviewed were actions advanced by the adaptation working group for prioritizing and guiding the city's efforts to implement adaptation planning. Additional discussion focused on identifying longer term measures that may not be feasible in the short-term but still should be considered for inclusion in the CAP.

Similar to the review process used by the building energy, and land use and transportation working groups between the first and second Advisory Committee meetings, the waste, water and green infrastructure, and adaptation working groups reviewed proposed policies and actions drawn from other cities for potential relevance and inclusion in Baltimore's CAP. They created shortlists of proposed measures that were presented and discussed at the third Advisory Committee meeting.

The Advisory Committee then provided input on how to refine proposed waste, water and green infrastructure measures by including composting, recycling and tree canopy preservation to ensure more feasible implementation. The presentation of a proposed adaptation approach included discussion of the various federal and state adaptation initiatives and a review of basic maps showing vulnerable populations and locations within the city based on the urban heat island effect that could inform priorities for adaptation planning. Refined short lists emerged from the meeting and those for waste, water and green infrastructure were quantified to determine potential GHG emissions reductions. Adaptation action steps were refined to inform how the city can proceed in comprehensively planning for adaptation.

Selecting Preferred Draft Measures

During the fourth Advisory Committee meeting (Review of Full List of Draft Proposed Measures, July 24, 2012) the Committee reviewed the full list of draft proposed measures developed during prior Advisory Committee and working group sessions. The draft list of proposed measures included estimated GHG emissions reductions so that the Committee could see the relative and cumulative impact of each measure in reducing the city's GHG emissions by 2020. During the session, the Committee refined measures to reflect feasibility considerations. The total GHG emissions reductions from this list of proposed measures did not yet reach the anticipated target of 15% reduction by 2020, so the Committee also included some additional suggestions for making the plan more aggressive in reducing emissions and meeting the 2020 target.

Following the selection of preferred draft measures, the Committee presented the measures for feedback and input from the Commission on Sustainability and the public at a Town Hall event.

Town Hall Meeting

A Town Hall meeting was held on June 26, 2012 to introduce the CAP and its proposed draft measures to the Sustainability Commission and the public. The Town Hall featured opportunities for the public to learn:

- Why Baltimore is taking action to address climate change.
- How the plan is being developed by a team of city-wide advisors representing communities, businesses and government entities.
- What measures are being proposed for addressing climate change.

The draft GHG emissions reduction measures developed through the Advisory Committee's efforts were presented at the Town Hall meeting. The Town Hall meeting also included a session for questions from the Sustainability Commission and the public focused on whether or not the proposed draft CAP measures covered all key issues and whether or not the measures sounded feasible. Questions and comments were captured and have been integrated into the development of proposed CAP measures.

A voting exercise and a budget exercise collected input from the public on the measures they felt should receive priority spending and be included in the CAP.

Climate Action Plan Town Hall meeting (Source: AECOM)

Voting Exercise

The voting exercise asked each Town Hall participant to "vote for those measures which you like the most" by placing stickers on posters displaying all the measures. The full results are in Appendix D. The five measures receiving the most votes in order are:

1. Growing a Green City 3.A: Increase the number of trees planted
2. Land Use & Transportation 1.A: Create high-quality pedestrian- and transit-oriented neighborhoods
3. Energy Savings & Supply 2.C: Lobby state to increase Renewable Portfolio Standard requirement to 33 percent by 2022[1]
4. Energy Savings & Supply 1.C: Require energy audits and retro-commissioning for city, commercial, industrial, and institutional buildings over 10,000 square feet
5. Growing a Green City 1.C: Compost organic material

1 After the Town Hall meeting the percentage was revised from 33 percent to 26 percent as a result of consultation with the state.

Budget Exercise

The budget exercise provided each Town Hall participant with $400 worth of CAP money and asked, "With a limited budget, where do you suggest the city spend money to create a more sustainable Baltimore?" Each participant placed the CAP money in the box or boxes to indicate which strategies they wished the city to invest. A total of $24,000 of CAP money was allocated by the public as follows:

1.	Street tree and community gardens	$6,600	(28%)
2.	Energy efficiency retrofits	$6,100	(25%)
3.	Pedestrian and bicycle infrastructure	$4,600	(19%)
4.	Renewable energy installments	$3,400	(14%)
5.	Food waste composting facilities	$2,800	(11%)
6.	Electric vehicle infrastructure	$500	(2%)

The preferences expressed through these exercises at the Town Hall meeting affirm that tree planting, energy efficiency and pedestrian/bicycle infrastructure improvement measures are strongly supported by the public. Benefits of these measures include reduced utility bills, shadier and cooler sidewalks and access to more walkable and bike-friendly options to get around the city.

Chapter 3

Greenhouse Gas Reduction Measures

Camden Yards (Source: AECOM)

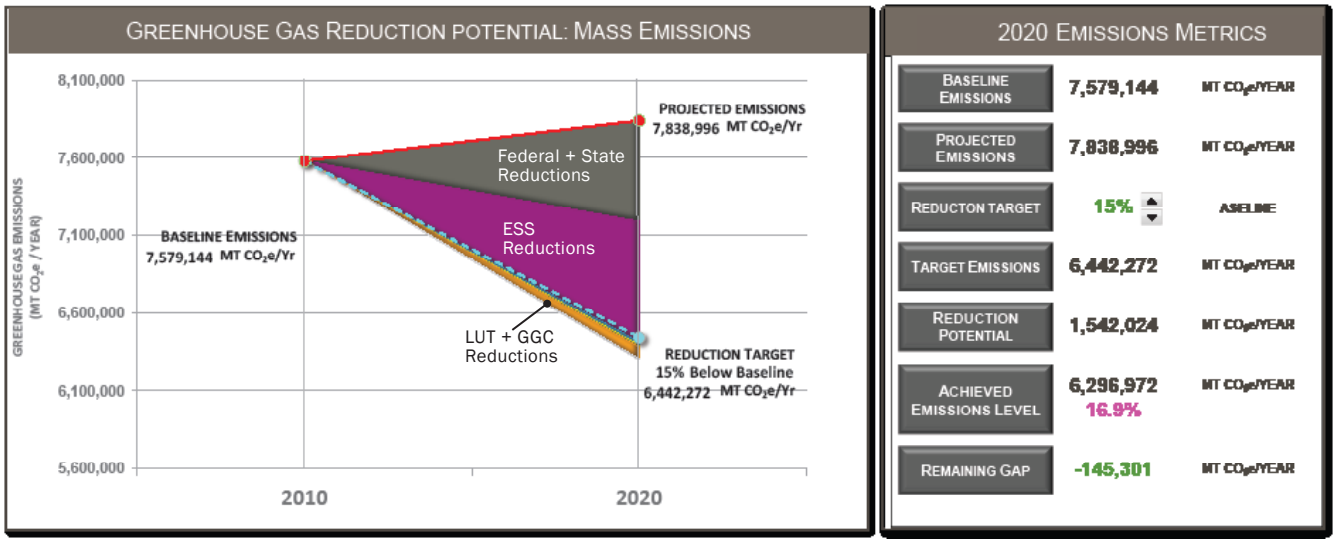
This chapter contains the GHG reduction measures developed through the planning process described in chapter 2, drawing on the expertise of the Advisory Committee and City of Baltimore staff. The measures are organized by Action Area (Energy Savings and Supply, Land Use and Transportation and Growing a Green City). These three Action Areas represent the key sectors within which Baltimore can reduce GHG emissions.

GHG Reduction Potential

By 2020, GHG emission reductions generated through implementing the three Action Areas have the potential to reduce total GHG emissions by 894,991 MT CO_2e/yr in 2020. GHG emission reductions attributed to state and federal actions have the potential to reduce GHG emissions by another 649,772 MT CO_2e/yr. Together, state, federal and GHG reduction strategies have the potential to reduce GHG emissions in Baltimore City by approximately 1,544,756 MT CO_2e/yr, which is approximately 17 percent below 2005 emission levels as measured from business-as-usual conditions in 2020. Note that the majority of the emission reductions are due to a measure proposing an increase in the state Renewable Portfolio Standard to 26 percent by 2022 (from the current level of 20 percent), and the city will need to work closely with the state and a large number of other stakeholders to facilitate this becoming a reality.

It should also be noted that there is an inevitable uncertainty factor in developing long-term projections of emission levels and the GHG reduction potential of CAP measures. Participation rates and performance levels have been estimated for each measure, and in some cases the city has been optimistic in the potential outcome. It should also be noted that there are a number of supporting (not quantifiable) measures included in the CAP that will result in additional GHG reductions by supporting quantified measures. The reductions from these measures can be counted in the CAP to the extent that they can be quantified in the future. Figure 5 summarizes the GHG reduction potential of the CAP measures and state legislation.

Figure 5 2020 Greenhouse Gas Reduction Potential



Note: Due to rounding there are slight variations between the totals in Figure 5 and Table 4.

Summary of Measures

Table 4 Summary of GHG Reduction Measures

MEASURE	MT CO_2e REDUCTION	% OF TOTAL REDUCTIONS	DETAILS ON PAGE
Energy Savings & Supply	**779,436**	**51%**	
ESS Strategy 1 Reduce energy consumption of existing buildings			
ESS 1.A Disclose residential energy bills and energy efficiency improvements at the beginning of the sale or rental process	49,780	3.2%	p. 29
ESS 1.B Benchmark and disclose energy performance and improvements of city -owned and privately-owned commercial, industrial and institutional buildings	45,630	3.0%	p. 30
ESS 1.C.a Require energy audits for city-owned and privately-owned, commercial, industrial and institutional buildings over 10,000 sq. ft. ESS 1.C.b Require retro-commisioning for city-owned and privately-owned, commercial, industrial and institutional buildings over 10,000 sq. ft.	119,510	7.7%	p. 31
ESS 1.D Conduct commercial and residential energy efficiency outreach	50,475	3.3%	p. 32
ESS 1.E Encourage model green lease provisions	Supporting		p. 33
ESS 1.F Conduct outreach programs in schools	Supporting		p. 33
ESS 1.G Retrofit Baltimore's street lights for more efficient energy usage	14,450	0.9%	p. 34
ESS 1.H Encourage switch from heating oil to natural gas	2,200	0.1%	p. 34
ESS 1.I Promote cool roof installations and other roofing technologies	6,930	0.4%	p. 35
ESS Strategy 2 Promote generation of renewable energy			
ESS 2.A Standardize permitting for renewable energy installations	Supporting		p. 36
ESS 2.B Conduct outreach for solar installations, to achieve 30 MW of PV installed in total, across all sectors (government, commercial, institutional, multifamily, and residential) by 2020	81,545	5.3%	p. 37
ESS 2.C Encourage State to increase Renewable Portfolio Standard to 26% by 2022	210,326	13.6%	p. 37
ESS Strategy 3 Expand and upgrade energy performance for major renovation and new construction			
ESS 3.A Adopt green building standards for new residential construction and major renovation	6,255	0.4%	p. 38
ESS 3.B Modify existing new homeowner and rehabilitation tax credit to include energy efficiency standards based on the Energy Star home certification program	4,695	0.3%	p. 39
ESS Strategy 4 Promote efficient community energy districts			
ESS 4.A Encourage new facilities to consider connecting to existing, proximate, co-generation facilities	Supporting		p. 40
ESS 4.B Encourage co-generation installation for replacing inefficient boiler plants	30,000	1.9%	p. 40
Baltimore Sustainability Plan Quantification Energy Savings and Supply Activities			
Savings due to Baltimore City Green Building Standards (commercial and multifamily)	10,995	0.6%	p. 41
Domestic appliance upgrades	17,355	0.9%	p. 41
Smart grid roll-out	129,290	7.4%	p. 41
Land Use & Transportation	**73,885**	**5%**	
LUT Strategy 1 Promote mixed-use development near transit			
LUT 1.A Create high-quality pedestrian- and transit-oriented neighborhoods	6,240	0.4%	p. 43
LUT 1.B Support mixed-use neighborhoods to increase access to goods and services	8,320	0.5%	p. 44
LUT Strategy 2 Support alternative commutes			
LUT 2.A Develop and promote incentives for individual transportation choices	33,980	2.2%	p. 45
LUT 2.B Promote establishment of qualified bike commute reimbursement programs	Supporting		p. 46

Note: Due to rounding there are slight variations between the totals in Figure 5 and Table 4.

MEASURE	MT CO_2e REDUCTION	% OF TOTAL REDUCTIONS	DETAILS ON PAGE
LUT Strategy 3 Explore parking strategy options			
LUT 3.A Explore the creation of a parking plan for city-owned parking	Supporting		p. 47
LUT 3.B Provide alternatives to monthly parking passes	Supporting		p. 48
LUT 3.C Reduce off-street parking requirements	Supporting		p. 48
LUT Strategy 4 Increase walking and biking			
LUT 4.A Develop a pedestrian master plan	2,600	0.2%	p. 49
LUT 4.B Support Safe Routes to Schools	Supporting		p. 50
LUT 4.C Expand and improve bicycle infrastructure	1,060	0.1%	p. 50
LUT Strategy 5 Increase efficiency in city fleet			
LUT 5.A Implement a centralized fueling program and route optimization software	1,235	0.1%	p. 51
LUT Strategy 6 Support cleaner vehicles			
LUT 6.A Support alternative-fuel infrastructure and encourage adoption of alternative-fuel vehicles	20,450	1.3%	p. 52
LUT 6.B Promote Fuel Efficient cargo handling in the Port of Baltimore	Supporting		p. 53
Growing a Green City	**38,935**	**3%**	
GGC Strategy 1 Divert waste from landfills			
GGC 1.A Develop a comprehensive recycling plan	Supporting		p. 56
GGC 1.B Reduce construction and demolition waste	4,580	0.3%	p. 56
GGC 1.C Compost organic material	7,225	0.5%	p. 57
GGC Strategy 2 Improve water efficiency			
GGC 2.A Repair water supply infrastructure	1,600	0.1%	p. 58
GGC 2.B Improve water efficiency in existing small residential buildings	6,290	0.4%	p. 59
GGC 2.C Improve water efficiency for new construction and major renovations of small residential buildings	1,050	0.1%	p. 59
GGC Strategy 3 Enhance the Urban Forest			
GGC 3.A Increase the number of trees planted	4,920	0.3%	p. 61
Baltimore Sustainability Plan Quantification Growing a Green City Activities			
Water appliance upgrades from new commercial building due to Baltimore City Green Building Standards	3,225	0.2%	p. 60
Climate appropriate planting and irrigation retrofits from existing landscaping and new landscaping requirements	5,910	0.4%	p. 60
Landscape waste diversion improvements	1,425	0.1%	p. 60
Water appliance upgrades during commercial building retrofits	2,710	0.2%	p. 60
Total CAP Reductions	**892,256**		
State reduction: Renewable Portfolio Standard (20% by 2022)	484,432	31%	p. 19
Federal reduction: Passenger vehicle and light duty fuel efficiency standards	165,340	11%	p. 19
Total Reductions	**1,542,028**		
2020 Projected Business-as-Usual GHG Emissions	7,838,996		
2020 Achieved GHG Emissions Level with GHG Reduction Measures	6,296,972		
Percent GHG Reduction from 2010 to 2020	**16.9%**		

Note: Due to rounding there are slight variations between the totals in Figure 5 and Table 4.

GHG Reduction Measures

Measures define the programs, policies, and projects that the city will undertake to accomplish its GHG emission reduction goals.

MEASURE STRUCTURE

Policy Mechanism
The measures are implemented through either voluntary actions, incentives, mandates, infrastructure projects, outreach efforts, strategic plans or the zoning code.

Time Frame
- Short-term (1-3 years) — Measures that can help jump-start CAP implementation within the first 1-3 years of the CAP.
- Mid-term (3-5 years) — Measures that may be best for implementing within the first 3-5 years following kick-off of the CAP.
- Long-term (5-8 years) — Measures that may be most feasible for implementation closer to 2020 and that can lay the groundwork for improvements beyond 2020.

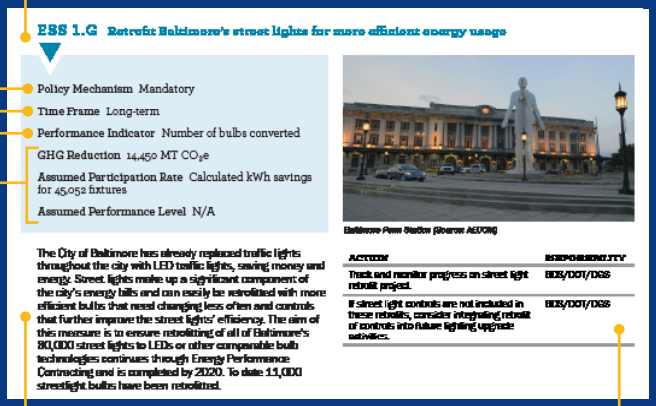
Performance Indicator
Performance indicators enable staff, the city, and the public to track implementation and monitor overall CAP progress.

Greenhouse Gas (GHG) Reduction Potential
The GHG Reduction Potential is the estimated annual emission reduction anticipated starting in 2020. Many measures generate directly quantifiable GHG reductions. However, not all measures have a quantifiable GHG reduction potential. Non-quantified measures are included in the CAP as supporting measures that facilitate the reduction potential of related quantified measures, or that complement the overall suite of measures and actions proposed in the CAP.*

Assumed Participation Rate
The assumed participation rate is an estimated level of engagement based on best available information. This is used to calculate anticipated GHG reductions as a result of the implementation of the measure.

Assumed Performance Level
The assumed performance level is an estimate of typical energy or GHG savings based on best available information. This is used to calculate anticipated GHG reductions as a result of the implementation of the measure.

Measure Name
The first letters refer to the Action Area (ESS, LUT or GGC), the number refers to the strategy, and the last letter identifies the measure.



Measure Description
The description of measures provides important background information describing the city's current activities to put the measure in context, some rationale and policy direction. Additionally, some descriptions provide detailed guidance that will be used in program implementation.

Action Steps
Actions identify specific steps that the city can take to implement each measure. These tables also identify responsible departments for each action. See Appendix A for the acronym table that defines the department acronyms.

**Non-quantified measures may have a GHG reduction potential but it could not be estimated at the time of plan preparation for one of the following reasons: (a) insufficient data exists for quantification, (b) no reliable quantification methodology currently exists to calculate these reductions, or (c) the GHG emission reductions attributable to the measure do not directly reference any component of the baseline GHG inventory, and thus cannot be counted towards the city's 2020 emissions reduction target. Supporting measures remain within the CAP because these actions do reduce emissions and have important community benefits.*

ENERGY SAVINGS & SUPPLY

Baltimore's buildings generate 79.5 percent of the city's greenhouse gas emissions. Typically buildings in Baltimore require five to six months of heating to keep building occupants comfortable in the late fall, winter and early spring as well as four months of cooling to mitigate the humid and warm spring through early fall. Given that Baltimore City has four separate but distinct seasons, building energy efficiency presents a significant opportunity for GHG reductions and associated cost savings. These reductions and operations savings can be achieved through measures that directly improve energy efficiency of existing and future buildings and promote long-term behavior change through audits and disclosure of energy performance. Changing individual and collective behavior to realize these benefits will require engagement of numerous city departments, colleagues, neighbors and friends. Whether through energy efficiency or clean generation, the implemented measures will have lasting implications on both the economy and the environment. Given the historical nature of Baltimore and its unique mix of building types, there are opportunities particular to Baltimore and its building stock that averages over 50 years old.

The total GHG reduction potential of the Energy Savings & Supply (ESS) measures is 779,436 metric tons of CO_2e per year, or approximately 51 percent of the total GHG reductions in the CAP.

Energy Modeling Assumptions

Sustainable Systems Integration Model - Energy (SSIMe) CAP Building Energy Analysis

In order to identify the energy and carbon reduction potential of Baltimore's building stock, an analysis was undertaken to identify the most cost-effective energy conservation measures that could be applied to the wide range of buildings (in terms of use, operation and age) that are seen across the city. At this high level of study, and without having conducted on-site energy audits of buildings, general strategies were developed that could be easily implemented through city policy or incentive schemes using AECOM's Sustainable Systems Integration Model Energy (SSIMe) tool, which provides data for the CAP toolkit. Further detail on the SSIMe CAP methodology is contained in Appendix E.

The energy savings measures were grouped into low, medium or high packages of performance based on the cost effectiveness.

Residential

- 'Low' package of measures assumes 7 percent electricity and 14 percent gas savings for single family, and 7 percent electricity and 16 percent gas savings for multifamily
- 'Medium' package of measures assumes 7 percent electricity and 23 percent gas savings for single family, and 7.5 percent electricity and 24 percent gas savings for multifamily
- 'High' package of measures assumes 16 percent electricity and 42 percent gas savings for single family, and 16.5 percent electricity and 42 percent gas savings for multifamily

Baltimore City Hall (Source: Baltimore City)

Commercial

- 'Low' package of measures assumes 4.5 percent electricity and 6.5 percent gas savings
- 'Medium' package of measures assumes 6 percent electricity and 14 percent gas savings
- 'High' package of measures assumes 11 percent electricity and 25.5 percent gas savings

ESS STRATEGY 1 Reduce energy consumption of existing buildings

The emissions associated with existing building stock in Baltimore makes up 79.5 percent of Baltimore's GHG inventory. The majority of the building stock that will exist in 2020 has already been built today, and will continue to exist for many years to come. It is therefore imperative that strategies are developed to help improve the operating efficiency of those buildings. The residential, commercial and industrial building sectors account for 27.5 percent, 26.3 percent and 25.8 percent of the inventory respectively. This section primarily focuses on measures targeting residential and commercial users. (The processes associated with industry tend to be regulated at a state or federal level, although this sector should be encouraged to operate in a more efficient way when possible.)

Single family row houses make up nearly 59 percent of Baltimore's housing stock while apartments represent nearly 24 percent and single family detached homes comprise approximately 17 percent. (Comprehensive Master Plan, 2009). The residential stock is pretty evenly split between owner-occupied homes and rental homes therefore GHG reduction measures are needed to target home owners, landlords and tenants. Measures targeting this sector range from education and outreach to encouraging behavior change, to mandates (such as disclosure of utility bills at the beginning of the sale or rental process (Measure ESS 1.A)), which should lead to market transformation. Where possible, measures have focused on low or no cost actions, or those that have a short payback period. More regulatory or mandate-based policies may be required in future updates to the Climate Action Plan depending on progress made towards the target. The operation of commercial buildings accounts for nearly 25 percent of Baltimore's GHG emissions. Benchmarking and disclosure of energy usage and the completion of audits and retro-commissioning will help lead to greater energy efficiency in the commercial sector (Measures ESS 1.B and ESS 1.C).

The Baltimore Energy Challenge (BEC) has shown considerable impact to date for 19 neighborhoods in the city. BEC activities include providing energy efficiency training and community based social marketing through partnerships and referrals to Project Lightbulb and Baltimore Gas and Electric (BGE) Energy Savers Quick Home Energy Check Up, and the installation of basic energy saving measures, such as light bulbs, low flow fixtures and pipe insulation. It is the intention of the Climate Action Plan to continue to expand this program for the residential and small business sectors, and apply it to the commercial sector for the first time. The high number of higher education institutions located within Baltimore also presents potential partnership opportunities for promoting a range of energy efficiency strategies (Measure ESS 1.D). Universities like Coppin State University and Johns Hopkins University are extremely progressive when it comes to energy efficiency and clean energy implementation. From LED lighting retrofits to solar generation, these universities have been leaders in power portfolio diversity and energy savings for not only the City of Baltimore, but the surrounding counties.

Baltimore row houses (Source: Flickr User eli pousson)

The 'split incentive' issue whereby landlords have little incentive to improve the energy efficiency of properties when they do not benefit from the savings is tackled by the Model Green Lease Measure (ESS 1.E). Green leases can create opportunities for the commercial sector to explore programs that yield savings for both tenants and landlords (and have also been shown to increase tenant occupancy and speed at which spaces are leased).

Energy education and outreach programs are run through Baltimore's more than 200 primary and secondary level schools and can help to introduce more energy cost saving strategies into homes through education of children. For example, the Empower Maryland grant was issued to encourage the adoption of energy efficiency by Baltimore City youth. By implementing different types of educational/ training programs and energy-saving technologies in schools, Baltimore City's youth become a vital part of the implementation of Baltimore's long-term progress towards GHG reductions (Measure ESS 1.F).

ESS 1.A Disclose residential energy bills and energy efficiency improvements at the beginning of the sale or rental process

Policy Mechanism Mandatory

Time Frame Short-term

Performance Indicator Percentage of transactions disclosing utility bills, percentage of transactions required to disclose utility bills, percentage of homes with energy efficiency improvements

GHG Reduction 49,780 MT CO_2e

Assumed Participation Rate Single Family 22 percent turnover, all homes with improvements made. Multifamily 26 percent turnover, all homes with improvements made. (American Community Survey 1 year estimate (2010))

Assumed Performance Level 'Medium' package of measures is installed in all homes sold or rented

The cost of heating and cooling a potential home should be a readily available, vital statistic, alongside, the number of bedrooms, dimensions of rooms and size of the yard. This measure aims to make utility costs an important factor in home real estate selection, by making the previous 12 months of energy bills available as part of the home information pack. In addition, this measure calls for information to be shared by the seller about any energy efficiency improvements made to the dwelling in the previous five years to help potential owners understand options and costs for easy energy efficiency improvements. The city will work with the Greater Baltimore Board of Realtors and other interest groups to develop the bill disclosure rule to help increase the speed at which this measure gets adopted, implemented and practiced. Once this practice has been in place for a few years, residential energy efficiency awards could be developed to reward those who are willing to publicly disclose their energy use year after year (note that Smart Meter technology may facilitate the assessment of this in the future).

To complement this measure, partnerships among the city and real estate professionals will be developed to conduct targeted outreach and education to home buyers. This educational outreach can include a welcome package with details of simple energy efficiency information for all home buyers, including available rebates and incentives for energy measures. It is assumed that being provided this information will encourage low cost energy efficiency measures to be installed at the point of moving in or shortly after.

Note that this measure could be seen as a precursor to a Residential Conservation Ordinance that may need to be phased in after 2020 depending on the success of voluntary measures towards reducing GHG reduction goals.

ACTION	RESPONSIBILITY
Establish an energy disclosure working group of representatives from the realtor association, utility, and Office of Sustainability to craft an energy disclosure bill for passage by the City Council.	Baltimore Office of Sustainability
Create the energy disclosure bill (consider modeling after the Montgomery County, MD bill and process including non-compliance penalties).	Energy Disclosure WG
Develop an information package on energy efficiency improvements for distribution by realtors and an outreach program to enhance implementation of the energy disclosure program.	Energy Disclosure WG/Baltimore Energy Challenge

Montgomery County Maryland passed a 2009 law mandating energy bill disclosure for real estate transactions. In addition to providing electric, gas and home heating oil utility bills for the previous 12 months, the seller/agent must provide information on the benefits of home energy audits[1], such as information on Maryland Home Performance with ENERGY STAR and energy efficiency improvements (e.g., insulation, home sealing, heating and cooling, lighting energy efficiency, and financing options). While this law requires disclosure of information about a home's utility usage it does not require the seller to undergo an energy audit or pursue implementation of energy efficiency measures. This law can serve as a potential model for Baltimore City.[2]

1 Montgomery County Department of Environmental Protection and Greater Capital Area Association of Realtors developed a website of energy efficiency opportunities and benefits http://gcaarocks.com/news_ektid5454.aspx

2 More information on the law can be obtained by contacting the Montgomery County Department of Environmental Protection or the Montgomery County Office of Consumer Protection http://www6.montgomerycountymd.gov/ocptmpl.asp?url=/content/ocp/Energy/faq.asp

ESS 1.B Benchmark and disclose energy performance and improvements of city-owned and privately-owned, commercial, industrial and institutional buildings

Policy Mechanism Mandatory

Time Frame Short-term

Performance Indicator Percentage of identified buildings reporting performance, percentage of buildings with energy efficiency improvements made

GHG Reduction 45,630 MT CO_2e

Assumed Participation Rate All non-residential sectors (21 percent of total building stock) assuming 26 percent turnover by 2020 and that 80 percent of turnover stock is over 10,000 sq. ft.. (Turnover percentage is based upon American Community Survey 1 year estimate for Baltimore (2010))

Assumed Performance Level 'Medium' package of measures and standard lighting upgrades saving 25 percent lighting energy

Buildings along Baltimore's Inner Harbor (Source: Flickr User TheBrit2)

To stimulate the market for improved energy performance in Baltimore's non residential building stock, this measure requires all city-owned and privately-owned, commercial, industrial and institutional buildings over 10,000 sq. ft. to benchmark and disclose their energy usage using the EPA's ENERGY STAR Portfolio Manager or other comparable technology. Building owners can use the energy disclosure information to differentiate their building from others to secure potential buyers or tenants. Potential buyers or tenants can gain insight into the value and potential long-term cost of a building. Operations and maintenance staff can use the results to encourage building owners and managers to pursue energy efficiency upgrades and demonstrate the return on investment for these projects.

The proposed benchmark process utilizes the EPA Portfolio Manager tool or other comparable technology, which compares a building's performance (in terms of total site energy use, site electric and natural gas use and site energy intensity (energy use per square foot)) to other similar buildings in the U.S.A highly favorable energy performance rating can enable a building to achieve ENERGY STAR certification, which can strengthen the marketability of a building for lease/rent or sale.

In order to help with market awareness, a city-wide recognition program may be created for the best performing buildings. In order to ensure market awareness, an outreach campaign will be developed in collaboration with the Building Owners and Managers Association (BOMA), and the Office of Sustainability around benchmarking, energy auditing, energy efficiency, retro-commissioning, and best practices for using building management systems. Philadelphia, Washington D.C., Austin, Seattle, San Francisco and New York city have recently adopted benchmark and disclosure ordinances. Minneapolis, Oakland and Boston are in the process, and many other cities are researching this recommendation.

Energy benchmarking and disclosure are also an economic booster, as energy services companies operating in New York City and San Francisco are seeing a 30 percent increase in business in response to local benchmarking ordinances (Building Energy Performance Assessment News).

As a long-term component of this measure, an energy performance certificate program could be developed for Baltimore buildings, whereby all buildings would be required to display their energy performance (an example is the ASHRAE Building Energy Labeling Program called Building Energy Quotient). Compliance could be enforced through a fining system, whereby responsible parties who do not comply with submission requirements or submit inaccurate information can be fined up to $500 per quarter.

Note that this could be a precursor to a Commercial Energy Conservation Ordinance (CECO) post 2020.

ACTION	RESPONSIBILITY
Drawing on examples (New York City, Seattle) craft an ordinance appropriate for Baltimore for City Council (see reference materials of the Institute for Market Transformation and the U.S. Department of Energy's State and Local Action Network for Energy Efficiency). Potentially consider a pilot program as a first step.	BOS/HCD (Dept of Housing and Community Development)/DGS (Dept of General Services)
Implement an outreach and education program that includes recognition for high performers to help drive improvement.	BOS

ESS 1.C.a Require energy audits for city-owned and privately-owned, commercial, industrial and institutional buildings over 10,000 sq. ft.
ESS 1.C.b Require retro-commissioning for city-owned and privately-owned commercial, industrial and institutional buildings over 10,000 sq. ft.

Policy Mechanism Mandatory

Time Frame Mid-term

Performance Indicator Percentage of applicable buildings conducting audits

GHG Reduction 119,510 MT CO_2e

Assumed Participation Rate Note this measure only requires an audit and no energy retrofits are required to be implemented. It is assumed 55 percent of total stock would implement a medium package of measures as result of audit (including 25 percent improvement in lighting energy efficiency).

Assumed Performance Level 'Medium' package of measures

1.C.a
An ASHRAE Level 2[1] building audit and can often identify simple no and low-cost energy efficiency measures to radically improve the efficiency of a building.

This measure recommends an energy audit (ASHRAE Level 2) for any building over 10,000 sq. ft., to be completed and filed by 2017. Buildings without a central chilled water system or central cooling or heating system are exempt. An energy audit and retro-commissioning [2] should be required every 10 years after the initial filing, a time frame for a feasible recurring schedule of audit and retro-commissioning activity and reporting should be specifically determined during measure implementation.

No energy audit would be required for buildings that have earned EPA's Energy Star for 2 of the 3 years prior to the audit requirement, have been documented by a registered design professional as an EPA Energy Star, or LEED certification.

This measure calls for energy audits, but does not require the implementation of energy efficiency measures that would be suggested by the energy audit. However, it is the intent of the energy audit to identify cost effective measures, and it is suggested that building owners evaluate those and consider implementation.

1 Evaluates the building energy systems in detail to define a variety of potential energy efficiency improvements. This should include the building envelope; lighting; Heating, Ventilation, and Air Conditioning (HVAC); Domestic Hot Water (DHW); plug loads; and compressed air and process uses (for manufacturing, service, or processing facilities).
2 A systematic process for optimizing the energy efficiency of existing base building systems through the identification and correction of deficiencies.

1.C.b
This measure recommends retro-commissioning of base building systems for any building over 10,000 sq. ft., to be completed and filed along with a retro-commissioning report by 2020. Retro-commissioning is a process that seeks to improve building equipment functionality and how the base energy systems[3] operate together, often years after the equipment was first installed. Depending on the age of the building, retro-commissioning can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life. In all, retro-commissioning improves a building's operations and maintenance procedures, enhancing overall building energy performance. While retro-commissioning often includes suggestions for capital improvements, the focus is on how to optimize the buildings base energy systems.

Currently, Baltimore Gas & Electric offers rebates up to 75% of the service costs, with a per-project cap of up to $15,000 for Enhanced Operations & Maintenance or $30,000 for full retro-commissioning services.

No retro-commissioning would be required for buildings that have undergone retro-commissioning by an approved retro-commissioning agent within 3 years prior to the required date of completion for retro-commissioning. Buildings without a central chilled water system or central cooling or heating system would be required to complete retro-commissioning for lighting systems and controls, and any other base building systems that are present in the location.

It is recommended that schools should be some of the first city-owned buildings to undergo the audit and retro-commissioning requirements. In addition to long-term energy efficiency benefits, these activities in schools will demonstrate leadership to the young generation, and generate near-term savings that are in considerable need.

3 Systems or subsystems of a building that use energy and/or impact energy consumption including: the building envelope, HVAC (heating ventilating and air conditioning) systems, conveying systems, domestic hot water systems, electrical and lighting systems.

ACTION	RESPONSIBILITY
Define terms of applicability, exemption and implementation time frame, technical resources, etc. for audits and retro-commissioning ordinance.	BOS/HCD/DGS
Secure passage of bill by City Council and Mayor.	BOS/Commission on Sustainability
Develop education and outreach materials for businesses and institutions regarding technical resources for audits, retrofits and retro-commissioning.	BOS/Advisory Committee Building Energy Working Group
Celebrate and recognize early participants in audits, retrofits and simple retrofit/LEED exemptions.	BOS

ESS 1.D Conduct commercial and residential energy efficiency outreach

Policy Mechanism Voluntary

Time Frame Short-term

Performance Indicator Number of buildings participating, percentage of buildings with energy efficiency improvements made

GHG Reduction 50,475 MT CO_2e

Assumed Participation Rate 10 percent residential; 10 percent non-residential stock

Assumed Performance Level 'Medium' package of residential measures; 'high' package of commercial plus 25 percent lighting efficiency improvement measures

Climate Action Plan Town Hall meeting (Source: AECOM)

The direct interaction with, and involvement of, the community in the Baltimore Energy Challenge (BEC) is a powerful mechanism for change. During the pilot year, BEC participants realized and averaged 6 percent savings on their electricity bill. BEC has since expanded into over 19 communities, and added small businesses, communities of faith, schools and energy assistance to their outreach efforts. This measure supports the continued development, funding and expansion of BEC to more residential communities, and to develop a program to target large commercial and institutional partners. Energy efficiency outreach should also include guidance on reducing process energy loads (i.e. appliances required to carry out daily tasks in an office, such as computers and printers, or in a home, such as stoves and washing machines).

In addition, the measure suggests that BEC expands to partner with Baltimore Colleges and Universities for a Sustainable Environment (B-CaUSE), a network of Baltimore area college and university professionals who are responsible for implementing sustainability strategies on their campuses, in order to explore energy outreach in institutional, off-campus, university and college housing. Continued expansion of the business outreach program to additional retail entities should also be targeted where funding and resources allow.

ACTION	RESPONSIBILITY
Collaborate with B-caUSE and other existing institutional sustainability outreach groups to explore effective ways to leverage resources and best practices.	BOS/Baltimore Energy Challenge
Identify pilot for a few key larger commercial and/or institutional partners to test how to effectively apply BEC approach.	BOS/Baltimore Energy Challenge
Identify the most receptive new neighborhoods for expansion of BEC in residential communities.	BOS/Baltimore Energy Challenge

BALTIMORE ENERGY CHALLENGE

ESS 1.E Encourage model green lease provisions

Policy Mechanism Voluntary

Time Frame Short-term

Performance Indicator Number of green leases signed

GHG Reduction Supporting

Assumed Participation Rate 26 percent of rental properties will turnover by 2020. Signing of green leases—target 10 percent of rentals (half the typical rate noted by Natural Resources Defense Council (NRDC))

Assumed Performance Level N/A

Commercial buildings that lease space to numerous tenants have limited incentive to pay for major capital expenses, such as energy retrofits, because most of the savings from reduced energy usage are realized by the tenant.

When a lease does permit the landlord to pass along some improvement costs, the value of the energy savings can be difficult to determine and measure. This measure calls for the city to encourage the use of model green lease provisions by commercial landlords and tenants that would encourage commercial landlords and tenants to share the liability and benefit of energy saving measures (and other sustainability measures) through a lease that encourages both installation of energy efficient equipment and energy efficient tenant behavior.

ACTION	RESPONSIBILITY
Convene a working group (perhaps a sub-committee of the Energy Reduction Working Group) that includes commercial realtors such as BOMA members to identify and review model green lease provisions for applicability in Baltimore.	BOS/BDC
Select and pilot the green lease provisions with engaged commercial partners.	BOS/BDC
Depending on outcomes of pilot testing, promote model green lease provisions via realtor associations, BOMA and other key stakeholders.	BOS/BDC

ESS 1.F Conduct outreach programs in schools

Policy Mechanism Voluntary

Time Frame Short-term

Performance Indicator Number of schools participating

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

With nearly 76 percent of the city's housing stock composed of single family residential units outreach directly to each housing unit can be cost and time prohibitive. This measure calls for encouraging schools to participate in existing energy efficiency education programs such as the Baltimore Energy Challenge or to develop energy curricula for use in classrooms as a way of encouraging change via school children in their homes. The State of Maryland passed environmental literacy requirements for school curricula, and we recommend that the City of Baltimore include strong energy conservation and efficiency curricula across all subjects. This approach can be a cost effective method for introducing energy efficiency into homes via education of the city's children. The Baltimore Office of Sustainability's "City Schools: Green, Healthy, Smart Challenges" program which awarded grants to more than 50 participating schools in 2012 and requires each school to complete an energy efficiency education project serves as a one model program that can be expanded through schools to reach a wider residential audience. The BEC also focuses their outreach efforts by creating "Energy Hub" schools, which educate and encourage behavior change and participation by students, teachers, parents and surrounding communities.

ACTION	RESPONSIBILITY
Build upon existing school energy conservation and education programs to expand outreach efforts for covering more students and more schools.	BOS/Baltimore City School System
Integrate educational components into curricula that promote awareness raising of energy efficiency by students in their homes and in school classrooms and buildings.	BOS/Baltimore City School System

ESS 1.G Retrofit Baltimore's street lights for more efficient energy usage

Policy Mechanism Mandatory

Time Frame Long-term

Performance Indicator Number of street lights converted

GHG Reduction 14,450 MT CO_2e

Assumed Participation Rate 45,052 street lights

Assumed Performance Level N/A

Baltimore Penn Station (Source: AECOM)

The City of Baltimore has already replaced traffic lights throughout the city with LED traffic lights, saving money and energy. Street lights make up a significant component of the city's energy bills and can easily be retrofitted with more efficient bulbs that need changing less often and controls that further improve the street lights' efficiency. The aim of this measure is to ensure that the retrofitting of all of Baltimore's 80,000 street lights to LEDs or other comparable bulb technologies continues through Energy Performance Contracting and is completed by 2020. To date 11,000 streetlight bulbs have been retrofitted.

ACTION	RESPONSIBILITY
Track and monitor progress on street light retrofit project.	BOS/DOT/DGS
If street light controls are not included in these retrofits, consider integrating retrofit of controls into future lighting upgrade activities.	BOS/DOT/DGS

ESS 1.H Encourage switch from heating oil to natural gas

Policy Mechanism Voluntary

Time Frame Long-term

Performance Indicator Percentage of energy saved

GHG Reduction 2,200 MT CO_2e

Assumed Participation Rate 2,000 homes

Assumed Performance Level 30 percent carbon saving in switching from fuel oil no. 2 to natural gas

Natural gas boiler (Source: Flickr User Harold Jarche)

Using natural gas for home heating rather than heating oil emits fewer GHGs and can be more cost effective (U.S. Energy Information Agency website, 2012). The Baltimore Office of Sustainability (BOS) seeks to promote operation cost savings and GHG emissions reductions by switching 2,000 residential oil burning furnaces to natural gas over 3 years as part of the City's home weatherization and energy efficiency retrofit programs. In addition, the Baltimore Departments of Housing and Community Development and General Services are exploring ways to convert heating systems from oil to natural gas to generate operational savings. A fund is currently being created to support these city-led efforts.

ACTION	RESPONSIBILITY
Prepare proposal for accessing funds via the Excelon Energy merger.	BOS
Identify other grant sources for supporting oil to gas conversions.	BOS/HCD/DGS

ESS 1.1 Promote cool roof installations and other roofing technologies

Policy Mechanism Voluntary

Time Frame Long-term

Performance Indicator Number and square footage of cool roofs installed

GHG Reduction 6,930 MT CO_2e

Assumed Participation Rate 30 percent cool roof coverage of commercial stock by 2020, 10 percent cool roof coverage of residential stock by 2020

Assumed Performance Level 1 percent savings from commercial (4,725 MT CO_2e), 1 percent savings from residential (2,205 MT CO_2e)

Cool roofs can help decrease the cooling required for individual buildings, and if applied extensively in an urban environment can reduce what is called the urban heat island effect. The urban heat island effect occurs when the extensive dark surfaces in a very urban environment (e.g. asphalt roofs and pavements) absorb heat from the sun and lead to hotter temperatures than would be experienced in rural or even suburban areas where natural vegetation provides cooling. Urban heat islands affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and GHG emissions, and heat-related illness and mortality. Cool roofs, which are generally light in color to reflect the sun's rays, can reduce the urban heat island effect and reduce cooling loads during hot days. In contrast, dark roofs absorb heat from the sun, which elevates urban temperatures and increases demand for air conditioning. Cool roofs are anticipated to save approximately 5 percent of cooling energy over a year[1].

This measure aims to promote installation of cool roofs and other highly efficient roof alternatives on large retailers, businesses, institutions and multi-tenant complexes via outreach, and/or volunteer efforts and potentially longer-term through building code modifications. The city will team with the Civic Works Energy Ready program and roofing trade associations to promote cool roof installations throughout commercial and residential sectors and work with the Baltimore Weatherization Assistance Program to install cool roofs when doing repair or roof replacement as part of green and healthy homes retrofits.

Alternative roofing options that can also lower energy losses, include green roofs and built-up roofs. Built-up roofs that meet ENERGY STAR ratings can lower roof temperatures and reduce the amount of heat transferred to the buildings. Green roofs tend to require more up front capital costs than cool roofs, but yield energy and water savings, in addition to extending roof life. The U.S. Postal Service installed a nearly 2.5 acre green roof on top of its New York City facility. The roof is anticipated to last twice as long as the former roof and save approximately $30,000 in annual energy costs alone. Green roofs can provide multiple social and environmental benefits in the form of leadership demonstration spaces such as Chicago City Hall's 22,000 square foot roof, which also supports local water and air quality benefits.

1 *AECOM engineer estimate May 2012.*

Baltimore Hilton Hotel roof (Source: Baltimore City) (left), White, Reflective, Cool Roof- Tremco HQ (Source: Flickr User Tremco Green HQ)(right)

ACTION	RESPONSIBILITY
Explore partnership with Civic Works' Energy Ready cool roofs program, roofing trade organizations and Weatherization Assistance Program to determine how a city-wide program could be developed for reaching large retailers, businesses and institutions as well as homes.	BOS/HCD
Identify pilot participants who may be willing to cover installation costs as part of a celebrated launch of a cool roof program, perhaps including a photo op with city leadership.	BOS

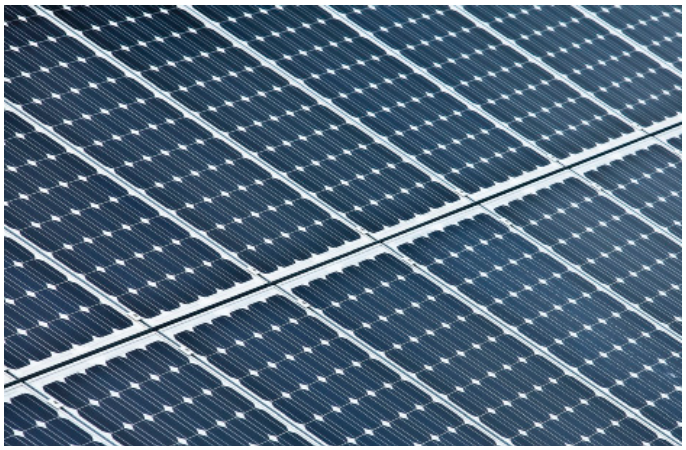
New York City's cool roof program is a partnership between the City's Building Department, volunteers and corporate and utility sponsors. Through the program, the city and has covered more than 2.5 million square feet of rooftop on over 380 buildings. More than 3,000 volunteers have contributed time and energy to this effort[1].

1 *Data from NYC Cool Roofs program has been obtained from the 2011 NYC Cool Roof Annual Review and website http://www.nyc.gov/html/coolroofs/html/about/faq.shtml .*

ESS STRATEGY 2 Promote generation of renewable energy

Beyond the federal renewable energy tax credits, there are few incentives for residential and commercial entities to invest in renewable energy strategies within the City of Baltimore. While the city may not be well-positioned in the short-term to provide financial incentives in the form of tax credits or subsidies for renewable energy installations, a standardized permitting process can reduce current time lags and associated costs with the review process, thus incentivizing installation of renewable energy projects (Measure ESS 2.A).

Standardized permitting could help to increase the number of homeowners who install renewable energy systems and receive the federal residential renewable energy tax credit for systems placed in service before December 31, 2016. Eligible systems include solar energy, wind, microturbines, geothermal heat pumps and residential fuel cells.



Photovoltaic Solar Panels (Source: AECOM)

ESS 2.A Standardize permitting for renewable energy installations

Policy Mechanism Incentive

Time Frame Short-term

Performance Indicator Number of renewable installations permitted, average time to permit renewable energy installations

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

Rooftop photovoltaic installation (Source: U.S. EPA photo by Eric Vance)

Renewable energy installation applications can be delayed in the permit review process as the city strives to confirm compliance with local regulations and public safety amidst quickly evolving renewable technologies. Time lags during review can serve as a disincentive for building owners and renewable installation investors to pursue renewable installations in Baltimore. This measure seeks to develop and implement standardized permitting requirements, costs and procedures for energy efficiency improvements and renewable energy projects for the residential and commercial sectors.

Also, the measure calls for the Office of Sustainability to work with the Maryland State Legislature, Maryland Public Service Commission and other relevant entities to pass legislation that allows for community renewable generation, and ensures at a local level, standardized permitting process for community renewable projects.

ACTION	RESPONSIBILITY
Review proposed building department modifications to the permit review process and identify aspects that can be enhanced with relevant renewable energy standards and performance measures.	BOS/HCD
Seek regulatory approval for community renewable generation.	BOS/Mayor's Office

Note: To encourage the federal government to renew tax deductible leasing of solar system to government entities (which operated under ARRA, but ended December 2011).

ESS 2.B Conduct outreach for solar installations, to achieve 30 MW of PV installed in total across all sectors (government, commercial, institutional, multi-family and residential) by 2020

Policy Mechanism Incentive, Outreach

Time Frame Short-term

Performance Indicator Number of systems installed

GHG Reduction 81,545 MT CO_2e

Assumed Participation Rate 10 percent of single family homes, multifamily homes and commercial stock have SWH installed; 15 percent of all single family homes have PV installed; 30 MW of PV installed across commercial and multifamily stock

Assumed Performance Level N/A

Solar water heater (Source: U.S. Government)

Building integrated solar energy systems - solar water heating (SWH) and photovoltaics (PV) - are the most appropriate renewable energy for the urban environment. Solar water heating systems are a simple and reliable way of using the sun's energy to provide hot water and can provide between 50 and 80 percent of a home's hot water demand during the year. Photovoltaics generate electric power by converting solar radiation into direct current electricity. The city will collaborate with BGE solar installation companies and the state to develop an outreach campaign to promote existing financial assistance and alternative financing mechanisms, such as power purchase agreements, and other information to help encourage home owners and commercial building owners to install systems. The city will also promote community solar legislation at the state level, and clarify and remove barriers for solar installations through Baltimore's updated zoning code.

ACTION	RESPONSIBILITY
Develop an outreach and information campaign, including residential power purchase agreements, to facilitate solar technology installation across building types by partnering with relevant local organizations.	BOS/Baltimore Energy Challenge/ Solar Installation Companies/ Maryland Energy Administration/ BGE

ESS 2.C Encourage state to increase Renewable Portfolio Standard to 26 percent by 2022

Policy Mechanism Lobbying state

Time Frame Mid-term

Performance Indicator Percentage of grid electricty provided by non-fossil fuels

GHG Reduction 210,326 MT CO_2e

Assumed Participation Rate N/A

Assumed Performance Level 26 percent renewable mix by 2022 (compared to 20 percent current requirement)

Wind Turbines off the coast of Wales (Source: Flickr User rory keegan)

Currently the Renewable Portfolio Standard (RPS) for the State of Maryland is 20 percent by 2022. Other states such as California, Colorado, and Delaware have higher RPS requirements. Maryland's RPS, unlike those of other states, aims to achieve its goal through in-state generation of renewable energy. In order for the state to achieve its current goal, off-shore wind generation needs to come on-line in Maryland. This measure seeks to encourage an increase in the RPS requirement, but most importantly, this measure looks to fully support the state in passing off-shore wind legislation to ensure the achievment of the current goal and any future increase. Making the electricity grid cleaner needs to be a three pronged approach – converting more of the grid to clean electricity, creating and keeping jobs in Maryland and developing localized projects on homes and businesses.

ACTION	RESPONSIBILITY
Encourage state to increase RPS standard to 26 percent by 2022. Partner with other local cities and organizations in this effort.	BOS/Commission on Sustainability/ Mayor's Office

ESS STRATEGY 3 Expand and upgrade energy performance for major renovation and new construction

The City of Baltimore is considering the adoption of the International Green Construction Code (IgCC), which creates a regulatory framework for new and existing buildings by establishing minimum green requirements for buildings while offering various routes to achieve compliance. The code acts as an overlay to the existing set of International Codes, including provisions of the International Energy Conservation Code and ICC-700, the National Green Building Standard, and incorporates ASHRAE Standard 189.1 as an alternate path to compliance. Adoption of IgCC will also yield GHG reduction savings for water and waste measures (Measure ESS 3.A). The State of Maryland adopted the IgCC as an optional requirement for new construction, applied to all commercial buildings as well as residential properties more than three stories high.

The Baltimore City Newly Constructed Dwelling Tax Credit encourages purchase and construction of new homes in the city. Upgrading this credit by including energy efficiency requirements (consider modeling the provisions on a similar Baltimore County program) can promote greater energy savings (Measure ESS 3.B).

ESS 3.A Adopt green building standards for new residential construction and major renovation

Policy Mechanism Mandatory

Time Frame Short-term (dependent on timing of city adoption of IgCC)

Performance Indicator Number of new and major renovation projects applying ICC-700 and IgCC

GHG Reduction 6,255 MT CO_2e

Assumed Participation Rate 80 percent of new single family homes

Assumed Performance Level 25 percent savings above the current code

While Baltimore has developed the Baltimore Green Building Standards for commercial and large residential buildings, these do not currently apply to small residential buildings. This measure calls for adoption of ICC-700, the National Green Building Standard for major residential renovation and new residential construction, which would ensure Baltimore's residential building stock achieves higher levels of energy performance compared to the current energy code.

The intent of the current energy code for multifamily residential and commercial new construction and major renovation is to promote energy efficiency. However, the current code's prescriptive approach may be cost prohibitive for a developer/owner while an outcome-based code offers greater flexibility of design approaches that can be used, and may be more economically feasible for the developer/owner, and still meets desired energy performance goals. The city should consider adoption of the outcome-based energy requirements of the IgCC to replace the current prescriptive energy code for new construction and major renovations for multifamily residential and commercial buildings.

Buildings with regulated loads (i.e., heating, cooling, lighting that is governed by codes) of 20 percent or more above the standard, require re-commissioning every five years, and require completion of all corrections suggested by the commissioning study that have a payback period of two years or less.

NOTE: Adoption of ICC-700 and IgCC in tandem may be the most time efficient way to upgrade the city's building codes. (Depending on timing and implementation of this measure, consider adoption of the most current version of ICC, IgCC, and IECC codes.)

ACTION	RESPONSIBILITY
Consider feasibility of an integrated approval process for city adoption of ICC-700 and IgCC.	BOS/HCD
Identify provisions of Baltimore Green Building Standards that need to be enhanced and select the relevant requirements and complementary requirements in IgCC for adoption and enforcement.	BOS/HCD
Consider inclusion of an incentive for new construction conversions of downtown spaces into multifamily residential.	BOS/HCD
As part of the IgCC standards, the city should consider tracking of modeled energy use for buildings in order to develop appropriate energy use targets for each building type. The code should also consider tracking actual energy use over time to compare with the modeled energy use for each new building.	BOS/HCD

ESS 3.B Modify existing new homeowner and rehabilitation tax credit to include energy efficiency standards based on the Energy Star home certification program.

Policy Mechanism Incentive

Time Frame Short-term

Performance Indicator Number of homes participating in credit program

GHG Reduction 4,695 MT CO_2e

Assumed Participation Rate 5 percent (single family homes only)

Assumed Performance Level 'Low' package of residential measures

Baltimore row houses (Source: AECOM)

Home rehabilitation can be a cost effective opportunity for making energy efficiency improvements. In the absence of incentives specifically targeted for residential energy efficient improvements, this measure calls for bundling energy efficient targets into the existing Newly Constructed Dwelling Tax Credit for Baltimore City.

In order to achieve the modified Newly Constructed Dwelling Tax Credit for Baltimore City, this measure calls for an existing home that is under going substantial rehabilitation, or a new construction dwelling to achieve Energy Star Certification. Energy Star certified homes are 15-30% more energy efficient than non-certified homes.

ACTION	RESPONSIBILITY
Explore how to integrate provisions used by other cities into existing Baltimore City Newly Constructed Dwelling Tax Credit provisions.	BOS/HCD
Raise awareness with realtor associations about tax credit and potential energy savings.	BOS/HCD
Explore the potential to modify energy efficiency standards for other Baltimore City tax credits including the Rehabilitated Vacant Dwelling Tax Credit, Home Improvement Tax Credit, and the Historic Landmarks and District Tax Credit.	BOS/HCD

ESS STRATEGY 4 Promote efficient community energy districts

A community energy district generates heat power locally to supply multiple buildings or a whole neighborhood. Generating power in this way can be more efficient than grid-based electricity. Baltimore already has some combined heat and power (CHP) plants. Baltimore has numerous colleges, hospitals and schools that could feasibly participate in a co-generation community energy district. These districts can reduce overall energy consumption through leveraging the generation capacity of existing facilities to support new and expanded facilities.

Johns Hopkins University (Source: Flickr User Let Ideas Compete)

ESS 4.A Encourage new facilities to consider connecting to existing, proximate, co-generation facilities

Policy Mechanism Voluntary

Time Frame Mid-term

Performance Indicator Number of new facilities connected to existing co-generation facilities

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

Johns Hopkins University (Source: Flickr User clio1789)

Construction of new district energy systems within an existing city can provide efficient heating and cooling but can be cost-prohibitive and require extensive planning. This measure calls for encouraging new commercial and industrial facilities to explore the creation of district energy systems either by linking with existing systems to obtain electricity and heat provision or from the development of a new co-generation facility. Where appropriate, the city should target areas of the city that contain sizable colleges/universities, hospitals, industrial zones, commercial zones or densely-planned areas where there could be opportunities for co-generation facilities. This is potentially a measure that could be explored in more detail in 2015 or once the economy picks up.

Johns Hopkins University is currently establishing a district energy network based on co-generation that may offer opportunities for linkages with neighborhood users.

ACTION	RESPONSIBILITY
Explore and identify opportunities regarding areas of the city in which existing co-generation is available for supporting additional new facilities.	BOS/DGS

ESS 4.B Encourage co-generation installation for replacing inefficient boiler plants

Policy Mechanism Incentive

Time Frame Mid- to long-term

Performance indicator Number of boiler plants replaced by co-generation facilities

GHG Reduction Potential 30,000 MT CO_2e

Assumed Participation Rate 10 MW of CHP assumed to be installed by 2020

Assumed Performance Level N/A

Combined heat and power plant (Source: Flickr User Bilfinger Berger Group)

For facilities that have a large and constant requirement for heat, co-generation can be a cost effective and energy efficient way of providing the required heat and generating electricity at the same time. This measure calls for encouraging existing hospitals, schools and universities with aging boiler plants to consider replacement with co-generation, which can efficiently generate both electricity and heat, often with natural gas as the fuel source. (Depending on the life cycle cost, biofuels could be a lower carbon fuel source.) This measure includes targeted outreach and assistance with alternative financing sources.

ACTION	RESPONSIBILITY
Explore and identify institutional opportunities through conversations and potential collaborations with the utility company or other energy companies and Baltimore's hospitals and educational institutions such as the JHU district energy program.	BOS/DGS

Baltimore Sustainability Plan Quantification
Energy Savings and Supply Activities

In addition to the new Energy Savings and Supply measures outlined in this chapter, there has been progress made through activities from the Sustainability Plan. Reductions from the activities that will contribute to the overall reduction have been estimated and are listed here.

- Savings due to Baltimore City Green Building Standards (commercial and multifamily) – 10,995 MT CO_2e
- Domestic appliance upgrades – 17,355 MT CO_2e
- Smart grid roll-out – 129,290 MT CO_2e

Total savings estimated from Sustainability Plan impact – 157,640 MT CO_2e

Potential Strategies for the Future (beyond 2020)

These strategies are recommended actions for inclusion in the CAP, but are thought not to be feasible for implementing prior to 2020 given anticipated economic and growth trends. However, changes in these trends may make these strategies more feasible for mid-term consideration.

- Encourage modified utility bill formats Collaborate with Baltimore Gas and Electric (BGE) to modify the billing format to provide larger format text and visualizations of consumption patterns to motivate behavior change. Customized at the household level, home energy reports on billing statements can show comparisons of how one household's energy usage compares to others in the neighborhood. Sharing this information can spur behavior changes in the home, with an average 1 to 3 percent energy reductions for households within a few months of receiving personalized household reporting (OPower.com, 2012).
- Promote residential renewable energy Require that residences above a certain size or containing a certain number of occupants to install a solar water heater sized to supply at least 50 percent of the hot water demand. Facilitate the application process for a grant from a clean energy rebate program.
- Expand use of solar Require that new or major rehabilitation for large-size commercial, office or industrial facilities that are 25,000 square feet or larger prior to rehabilitation incorporate renewable energy generation (on- or off-site) to provide a minimum of 10 percent or more of the project's energy needs. Major rehabilitation could be defined as additions of 25,000 square feet or greater for office/retail commercial or 100,000 square feet or greater of industrial floor area.
- Outcome based incentives Reward buildings that perform above a certain level of performance. Standardized levels of performance could be developed through review of the benchmarking data collected as part of ESS 1.B.
- Switch to gas-fired power plants By aggregating 1/6th of the electricity customers within the City of Baltimore, there would be enough demand to influence the conversion of a coal fired power plant to natural gas, or to build new natural gas power plants within the city. Transition 100 MW of coal to 100 MW of natural gas. This would involve creating an energy supplier that aggregates the customers, who have specific criteria for renewable or natural gas produced energy. Because of the demand, it would encourage energy suppliers to increase the availability of these types of power generation as part of the grid mix.
- Reduce refrigerants Restrict the use of certain refrigerants to reduce the quantities of refrigerants released into the atmosphere due to the neglect or insufficient maintenance of HVAC systems.
- Promote institutional renewable energy Encourage institutions within Baltimore that are classified as high electricity users to adopt renewable energy practices and expand their portfolio of renewable energy.

LAND USE & TRANSPORTATION

Emissions from the transportation sector makes up 15.6 percent of Baltimore City's GHG inventory (approximately 1,183,046 MT CO_2e/year in 2010). The vast majority of these emissions come from the use of the privately-owned car (referred to as 'vehicle miles traveled' or VMT), followed by emissions form the port, metro, bus and light rail systems. Since the modes of travel residents use is closely linked to land uses, the Climate Action Plan addresses land use and transportation in the same sector. The overall goal of this section of the CAP is to try and reduce VMT by residents and employees. The density of development, mix of uses, proximity to transit, and street design, as well as the availability, affordability, ease of alternative modes of travel, and other factors influence how far residents and employees travel to meet daily needs, and whether they choose to walk, bike, use public transit or drive.

The Land Use and Transportation strategies are focused around creating high quality pedestrian and transit-oriented mixed-use developments that locate everyday needs close to each other and public transportation. This concentration of services near transit can increase use of alternatives to driving cars, such as walking and biking, thus reducing VMT. The City of Baltimore will promote mixed-use development near transit and improve pedestrian and bicycle infrastructure to encourage the formation of mixed income communities. The city will also support alternative commutes and explore parking strategies for city-owned parking that can reduce VMT.

The investments and initiatives described in the strategies and measures below will help to reduce GHG emissions, relieve roadway congestion, reduce air pollution, and improve safety and health for residents.

The total GHG reduction potential of the Land Use and Transportation (LUT) measures is estimated to be 73,885 MT CO_2e per year, or approximately 5 percent of total GHG reductions in the CAP.

Baltimore Inner Harbor (Source: Flickr User Camera Slayer)

Biking in Baltimore (Source: Baltimore City)

LUT STRATEGY 1 Promote mixed-use development near transit

Baltimore's downtown was designed prior to common ownership of the car and therefore land use patterns in the city's core are dense and well-distributed. However, more recent development focused on auto-oriented development and separation of uses, thereby increasing distances between destinations and the need to drive. Mixed-use development provides easier access to goods and services and development near transit makes it easier to access and use transit services. Through increasing access to goods and services and increasing the options to reach those amenities, the need for automobile trips can be reduced. As more than 200,000 Baltimore residents (almost one third of the city's population) do not have access to a car, mixed-use and transit-oriented neighborhoods will also provide more equitable transportation options for those residents.

The city's Comprehensive Plan calls for transit-oriented and mixed-use development to reinforce neighborhood centers and main streets. The new zoning code, TransForm Baltimore, will contain zoning categories that will promote pedestrian-oriented, mixed-use development, allow for the creative and flexible reuse of older buildings, encourage campus master planning, and protect open space. New design guidelines in TransForm Baltimore will allow neighborhoods to become pedestrian-friendly and attractive places to shop, work and live.

The measures associated with this strategy will promote development that makes it safer, easier, more convenient and more enjoyable to walk, bicycle and use transit.

LUT 1.A Create high-quality pedestrian- and transit-oriented neighborhoods

Policy Mechanism Varied

Time Frame Mid- to long-term

Performance Indicator Percentage of new development that is located near transit

GHG Reduction 6,240 MT CO_2e

Assumed Participation Rate 10,000 new residential units by 2020, 60 percent of which are transit-oriented

Assumed Performance Level 25 percent VMT reduction potential

This measure focuses on promoting redevelopment policies that reduce VMT through the creation and/or enhancement of neighborhoods that increase access to pedestrian and transit facilities. This includes incorporating Complete Streets design guidelines into neighborhood planning and design and creating incentives for development near transit, such as adjacent to the proposed Red Line light rail stations.

The Baltimore City Council's Complete Streets resolution directs the Departments of Transportation and Planning to apply Complete Streets principles to the planning, design, and construction of all new city transportation improvement projects. The Southeast Baltimore Complete Streets draft plan will serve as a sustainable infrastructure improvement guide for Southeast Baltimore and educational document and a toolkit for neighborhoods to use to create their own Complete Streets designs.

The adoption and implementation of TransForm Baltimore will facilitate development near pedestrian and transit facilities. Provisions of the new zoning code that will support pedestrian-oriented development near transit include:

- Commercial zoning districts that focus on commercial clusters and pedestrian-oriented corridors of commercial areas (C-1, C-1-E, C-2).
- Downtown zoning sub-districts including those that are predominately pedestrian-oriented in nature (C-5-DC, C-5-IH, C-5-DE).
- Transit Oriented Development District locates development (residential with varying levels of mixed-uses) near transit, reduces the parking requirements for the associated development and requires bicycle parking.

An emphasis on developing transit-supportive uses in neighborhoods would create more pedestrian-friendly neighborhoods that can encourage mixed income communities near existing and/or potential rail stations.

ACTION	RESPONSIBILITY
Continue to incorporate Complete Streets design guidelines into neighborhood planning and design.	Planning and Baltimore City DOT (Dept of Transportation)
Incentivize new mixed-use development near transit through the adoption and implementation of the updated zoning code regulations and infrastructure investment.	Planning and Baltimore City DOT
Identify priority areas for infrastructure investment to incentivize pedestrian- and transit-oriented development.	Planning and Baltimore City DOT
Utilize the Vacants to Value program to encourage infill development to connect neighborhoods.	Baltimore Housing (Dept of Housing and Community Development)
Use WalkScore as a measure for walkability.	Planning and Baltimore City DOT

LUT 1.B Support mixed-use neighborhoods to increase access to goods and services

Policy Mechanism Varied

Time frame Long-term

Performance Indicator Percentage of new development that is mixed-use

GHG Reduction 8,320 MT CO_2e

Assumed Participation Rate 10,000 new residential units by 2020, 80 percent of which are mixed-use

Assumed Performance Level 25 percent VMT reduction potential

(Source: Baltimore City)

This measure focuses on promoting redevelopment policies that reduce VMT through the creation and/or enhancement of mixed-use development in neighborhoods to create walkable access to jobs, services and amenities. The focus on supporting and promoting 20-minute neighborhoods will create convenient, safe, and pedestrian-oriented access to places and services residents use on a daily basis that are near and/or adjacent to housing. These destinations and amenities include: transit, shopping, groceries, schools, parks, and social activities. A 20-minute neighborhood means where people go, and get to, in about twenty minutes.

The adoption and implementation of TransForm Baltimore will facilitate development near pedestrian and transit facilities. Provisions of the new zoning code that support mixed-use, 20-minute neighborhoods include:

- Office Residential Zoning District allows a mix of office and residential development.
- Rowhouse Mixed-use Overlay District allows residential occupancy with first-floor non-residential.
- Detached Mixed-Use Overlay District allows residential occupancy with first-floor non-residential.

Housing typology maps for Baltimore City could be utilized to target some of the approximately 30,000 abandoned properties in Baltimore, which can serve as opportunities for walkable, mixed-use infill development and build on existing neighborhoods with 20-minute walking distances. Enhancing the quality and diversity of uses in the city's neighborhoods will help decrease transportation-related GHG emissions and improve residents' quality of life.

ACTION	RESPONSIBILITY
Focus on supporting and promoting 20-minute neighborhoods to improve local access to commercial, retail, employment and other uses.	Planning
Enhance existing neighborhood-serving commercial centers and districts.	Planning/ Baltimore Development Corporation (BDC)
Utilize the Vacants to Value program to encourage reuse of buildings.	Baltimore Housing
Incentivize new mixed-use development near transit through the adoption and implementation of the updated zoning code regulations and infrastructure investment.	Planning
Identify priority areas for investments to incentivize mixed-use development.	Planning/ Baltimore City DOT/BDC/HCD
Work with the Department of Planning to support the implementation of TransForm Baltimore to support the land use goals of the CAP.	BOS/Planning

LUT STRATEGY 2 Support alternative commutes

According to the U.S. Census Bureau's 2006-2010 5-year American Community Survey, the majority of Baltimore residents (59 percent) commute to work by driving alone. Approximately 18.5 percent of residents commute by public transportation, 11 percent carpool, 6.8 percent walk, 2.7 percent work at home, and 1.8 percent use other means. Reducing single-occupancy automobile trips in Baltimore by providing transportation alternatives such as bicycling, walking, etc. will help to reduce VMT and GHG emissions.

Transportation demand management (TDM) is a general term for strategies that result in more efficient uses of transportation resources. TDM strategies aim to reduce single-occupancy automobile trips, increase awareness of alternative travel options, and facilitate a change in travel and commuting patterns. These strategies often target commute trips associated with employment within a community, but they can also encompass non-employment trips, such as those for shopping or recreation.

An existing program that promotes TDM strategies in Baltimore is the Waterfront Partnership of Baltimore's transportation initiative, which promotes transportation options in Harbor East and the Inner Harbor. This strategy seeks to identify other areas where alternative travel and commute options can be promoted to individuals who would like to utilize alternative travel and commute options. The primary measures that the City of Baltimore will seek to emphasize within a TDM program are those that can be targeted to provide individual residents with information, education and support.

LUT 2.A Develop and promote incentives for individual transportation choices

Policy Mechanism Voluntary, Incentive

Time Frame Short- to mid-term

Performance Indicator Percentage of employee participation city-wide

GHG Reduction 33,980 MT CO_2e

Assumed Participation Rate 20 percent of existing and 20 percent of new employees using a TDM program on a voluntary basis, 25 percent of city employees using a TDM program on a voluntary basis

Assumed Performance Level VMT reduction assumptions associated with each TDM measure

This measure is centered on creating personalized, resident-based transportation demand programs to educate residents on the alternative transportation modes available for their use. Information will be provided by developing individualized marketing programs in selected areas to increase awareness of travel options and non-motorized infrastructure improvements in the City of Baltimore. These individualized marketing programs will act as a campaign in the target areas for a set amount of time. Programs and infrastructure that can be promoted include the Waterfront Partnership of Baltimore, Commuter Choice Maryland, Zipcar, the new bike share program currently under development called B-Cycle, the Bicycle Master Plan Update, and the Maryland Transit Administration's Special Fare discount programs.

The individualized marketing programs aim to provide individuals with resources and support for trying travel options other than driving. The individualized marketing programs will provide customized information packets based on the resident's interest (including resources such as maps and brochures), hosted events such as group walks and bicycle rides, and workshops aimed at bicycle and pedestrian safety, transit use, and community health and safety benefits. Another incentive is the parking cash-out, a process whereby employers who provide subsidized parking for their employees offer a cash allowance in lieu of a parking space. The intent of parking cash-out is to reduce vehicle commute trips and emissions by offering employees the option of "cashing out" their subsidized parking space to take transit, bike, walk or carpool to work.

The program will target those with a lack of information and provide frequent and responsive contact to engage residents. The program will provide information and encouragement to residents through communication forms such as newsletters, emails, a program website, social media updates, and mailings. Residents would opt-in to participate in the city's information campaign.

ACTION	RESPONSIBILITY
Identify key geographic areas to be focus areas for the individualized TDM program.	Baltimore City DOT
Create an individualized/personalized resident-based transportation demand marketing program in targeted communities.	Baltimore City DOT
Survey large employers to determine level of interest in private employer TDM programs.	Baltimore City DOT
Retain and promote the pre-tax transit purchase benefit offered to city employees.	Baltimore City DOT

LUT 2.B Promote establishment of qualified bike commute reimbursement programs

Policy Mechanism Voluntary, Incentive

Time Frame Short- to mid-term

Performance indicator Number of employees participating in bike reimbursement program, number of employers offering the benefit

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

(Source: Baltimore City)

(Source: Baltimore City)

This measure calls for employers to adopt a bike commute reimbursement program, which provides a financial incentive for employees to regularly commute to work via bicycle. Promotion of bicycle commuting is a supporting measure that can help reduce VMT and transportation related GHGs by reducing the number of vehicles on the road, traffic congestion and idling of vehicles. Incentivizing bike commuting also places it on a more equal footing with reimbursement for transit and "free" parking benefits offered by numerous Baltimore employers.

Qualified bike commute reimbursement is recognized by the IRS as a qualified transit fringe benefit (see IRS section 132f). An employer provided bike commute reimbursement program that adheres to the rules in the IRS code is exempt from withholding and payment of employment taxes.

For an employee, a bike commuter reimbursement program can provide up to $20 per month for the purchase, repair, maintenance and storage of a bicycle for regular commuting. Totaling up to $240 per year, this incentive can encourage alternative commuting and can be paid to employees as a tax free benefit.

The presence of more bicycles on city streets can help to raise awareness of alternative commuting options, may increase safety of bicycle commuting and promote more bike commuters. The growing interest in bike commuting could also generate greater support for enhancing the pedestrian and bike friendly features of the city. Also, bike commuting can help to relieve crowding on high use public transit routes.

This incentive can promote health and wellness by encouraging an active commute for employees.

ACTION	RESPONSIBILITY
Demonstrate leadership of city government by adopting this program for city employees.	Baltimore City DOT
Encouraged large employers to adopt program.	BOS

LUT STRATEGY 3 Explore parking strategy options

Cheap and plentiful parking in downtown areas can encourage commuters to drive to work. Parking strategies can help to lower GHG emissions by influencing mode choice and impacting the number of vehicle miles traveled. Parking cash-outs and parking pricing are strategies that can incentivize a change in mode share and a reduction in VMT. Zoning code regulations can also influence parking supply and location. Baltimore's zoning code is currently being updated. The updated zoning code, TransForm Baltimore, includes new zoning categories that will promote pedestrian-oriented, mixed-use development close to existing and planned transit stations and reduce off-street parking requirements.

Exploring options for a city-wide parking strategy will provide a roadmap to implement efficient and convenient parking while also providing for alternative transportation options.

Parking garage (Flickr User: Scutter)

LUT 3.A Explore the creation of a parking plan for city-owned parking

Policy Mechanism Incentive

Time Frame Mid-term

Performance Indicator Number of alternative commutes per month

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

A parking plan that identifies the appropriate amount of short- and long-term parking downtown can balance supply and demand. Identifying the right balance between short- and long-term parking includes consideration of both the number of spaces available and the price per hour of the types of spaces. Parking pricing can influence the use and availability of parking at any given time. A parking pricing strategy that identifies the appropriate cost of various types and locations of parking downtown can influence supply and demand to alleviate the need to circle blocks while searching for an on-street parking spot and incentivize various modes of commuting to downtown.

ACTION	RESPONSIBILITY
Carry out a parking study that would include review of existing parking patterns, including the number of trips and the vehicle miles per trip generated by short-term and long-term parking users, pricing strategy, limiting long-term spaces, etc.	Parking Authority/ Department of Planning/ Department of Transportation
Provide priority locations for carpool and vanpool vehicles at a discounted rate.	Parking Authority/ Baltimore City DOT
Explore the ability to gather and transmit information about available parking spaces.	Parking Authority/ Baltimore City DOT
Identify parking subsidies for city employees and determine if any should be eliminated or provided as a cash-out option.	Parking Authority/ Baltimore City DOT

LUT 3.B Provide alternatives to monthly parking passes

Policy Mechanism Incentive

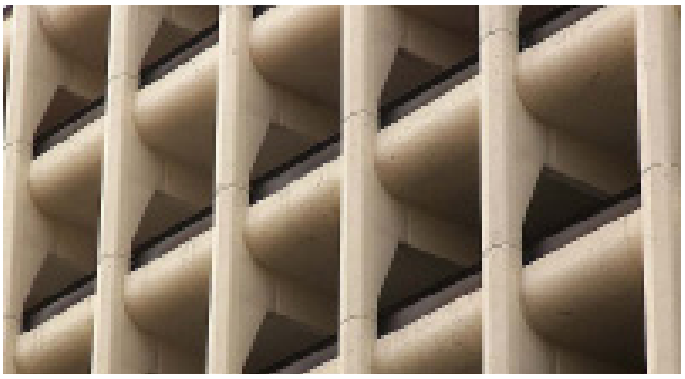
Time Frame Mid-term

Performance Indicator Number of participants in alternative parking programs

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A



Parking garage (Source: Flickr User greg.karpoff)

City of Baltimore employees and other commuters to downtown can purchase monthly parking passes for city-owned garages. Monthly parking passes limit commuters' transportation options because they pay for their commute mode on a monthly rather than daily basis. Alternatives to monthly parking passes, such as "coupon books" or passes that can be used on individual days, allow commuters the flexibility to make transportation decisions that best fit their needs on a daily basis.

ACTION	RESPONSIBILITY
Establish a pilot program that offers "coupon books" of parking days to city employees instead of an unlimited monthly parking pass.	Parking Authority, Baltimore City DOT, BOS
Expand the "coupon book" program to other city garage users if the pilot program is successful.	Parking Authority, Baltimore City DOT, BOS

LUT 3.C Reduce off-street parking requirements

Policy Mechanism Zoning Code

Time Frame Short- to mid-term

Performance Indicator Percent reduction in off-street parking

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

Parking meter in Fells Point (Source: Flickr User Craig Oppy)

Support the adoption and implementation of TransForm Baltimore in order to reduce off-street parking. The new zoning code will establish parking maximums for off-street parking and exempt some zoning districts from off-street parking requirements (C-1, C-1-E, C-5 and all non-residential uses in the R-MU and D-MU Overlay districts). It will also reduce parking requirements in District C-2 (the first 2,500 square feet are exempt from the requirement unless located in a multitenant configuration) and in all commercial districts, if no more than 2 parking spaces are required, they do not need to be provided. Off-street shared parking will be permitted as well as land banking of a portion of the site for new developments that would be required for parking if the applicant can support the reduced parking requirements. For new developments and/or new parking use applications, paying a fee in-lieu of meeting parking requirements will also be permitted on a case-by-case basis if approved by the Planning Commission.

ACTION	RESPONSIBILITY
Work with the Department of Planning to implement the portions of the new zoning code that support sustainability and the goals of the CAP.	BOS and Department of Planning
Provide a summary of, or links to, the portions of the zoning code that support reductions in off-street parking and sustainable transportation on the BOS website.	BOS

LUT STRATEGY 4 Increase walking and biking

Walking or biking instead of driving reduces GHG emissions, increases personal fitness, and adds to the sense of community as more people interact on sidewalks and bike paths. This strategy is targeted at making walking and biking more attractive by making it safer, easier and more enjoyable for commuters and recreational walkers and bikers of all levels of expertise. This strategy builds on the success of the Bicycle Master Plan approved in 2006 and the Sustainability Plan recommendations that support walking and biking in Baltimore.

Baltimore residential neighborhood (Source: AECOM)

LUT 4.A Develop a pedestrian master plan

Policy Mechanism Mandatory

Time Frame Mid- to long-term

Performance Indicator Number of improved intersections, number of miles of improved sidewalks

GHG Reduction 2,600 MT CO_2e

Assumed Participation Rate N/A

Assumed Performance Level Ease of street crossing goes from medium to high. 85 percent of the city would have improved pedestrian conditions.

The City of Baltimore does not currently have a pedestrian master plan. As called for in Baltimore City's Comprehensive Plan, this measure will develop a city-wide pedestrian master plan. Development of the plan will occur in coordination with the Americans with Disabilities Act (ADA) Transition Plan, the pedestrian safety committee and Complete Streets legislation with a focus on pedestrian safety provisions, such as crosswalks, countdowns and ADA compliance, in addition to sidewalk expansion opportunities. After the plan is developed, the city will work to ensure implementation.

ACTION	RESPONSIBILITY
Develop a pedestrian master plan that could include but would not be limited to: • Developing a sidewalk GIS shapefile, ideally with information regarding sidewalk width, buffer, and obstructions; • Identifying where sidewalks are needed; • Using the Pedestrian Intersection Safety Index to identify intersections likely to be difficult or unsafe for pedestrians; • Building on the work started in the draft ADA Transition Plan. Focus on evaluating ADA compliance and implementing the ADA Transition Plan once it is completed; • Evaluating opportunities to convert underutilized roadway space for pedestrian use; and • Considering pedestrian safety issues at major intersections and along arterial roadways.	Baltimore City DOT
Install pedestrian infrastructure improvements identified in the Access to Rail Stations study.	Baltimore City DOT
Install pedestrian countdown signals at all signalized intersections.	Baltimore City DOT

LUT 4.B Support Safe Routes to Schools

Policy Mechanism Voluntary

Time Frame Short-term

Performance Indicator Number of schools participating in the program

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

The Sustainability Plan calls for the expansion of the Safe Routes to Schools program in order to improve the safety of children walking and biking to school. In addition to providing a safer way to travel to school, the Safe Routes to Schools program promotes physical activity for children, which provides health benefits. Beginning in 2007 through 2011, Baltimore City received federal funding for Safe Routes to Schools programs, including infrastructure improvements, education and outreach, and coordination. This measure advocates for the continued funding and support of the Safe Routes to Schools program.

ACTION	RESPONSIBILITY
Apply and advocate for funding for the Safe Routes to Schools program.	Baltimore City DOT
Explore ways to incorporate more charter schools into the Safe Routes to Schools program.	Baltimore City DOT
Provide information to parents on school transportation and Safe Routes to Schools during the school selection process for neighborhood and charter schools.	Baltimore City DOT

LUT 4.C Expand and improve bicycle infrastructure

Policy Mechanism Infrastructure

Time Frame Mid- to long-term

Performance Indicator Number and miles of improved and new bike lanes and paths

GHG Reduction 1,060 MT CO_2e

Assumed Participation Rate 0.9 percent bicycle commute mode share, 2.5 miles average bike trip length

Assumed Performance Level 60 miles of new bicycle lanes or other facilities

In 2006, the City of Baltimore adopted the Bicycle Master Plan, which proposed new and improved bicycle lanes and other bike infrastructure. Approximately 113 miles of bike lanes exist in the City of Baltimore. Implementation of the current Bicycle Master Plan is ongoing and the Bicycle Master Plan Update is planned. This measure will expand and improve bicycle infrastructure in conjunction with the Sustainability Plan recommendations and with the Bicycle Master Plan Update, including incorporating potential bike dock station locations for the planned bicycle share program, B-Cycle, and the coordination of long-term bike storage with the new zoning code regulations.

ACTION	RESPONSIBILITY
Continue to implement the Bicycle Master Plan through the following core actions: • Expanding bicycle facilities in neighborhoods that have not received bike facilities to date; • Identifying key corridors for cycle track improvements; • Focusing on facility types to attract a broader set of users (separated bike facilities and bike boulevards); and • Expanding Baltimore Bike Trail system to connect bike commuter routes.	Baltimore City DOT
Develop an off-road trail aspect to the Bicycle Master Plan, building on and linking the existing trail network.	Baltimore City DOT
Support the creation of the bicycle sharing system through the current planning stages and implementation.	Baltimore City DOT, BOS
Install bicycle infrastructure improvements identified in the Access to Rail Stations study.	Baltimore City DOT

LUT STRATEGY 5 Increase efficiency in city fleet

Efficient operations of the municipal fleet can save fuel costs and reduce GHG emissions. Fuel management software and route optimization software can provide managers with accurate information to inform decisions about which vehicles need maintenance or upgrades and which routes would be most time and fuel efficient. Scarce public dollars saved through optimized fleet management could be re-allocated to investments in further efficiencies such as alternative vehicles and alternative fueling infrastructure.

Baltimore garbage truck (Source: Flickr User Sidereal)

LUT 5.A Implement a centralized fueling program and route optimization software

Policy Mechanism Infrastructure

Time Frame Short- to mid-term

Performance Indicator Amount of fuel consumption compared to initial baseline

GHG Reduction 1,235 MT CO_2e

Assumed Participation Rate Approximately 1,600 vehicles in municipal fleet

Assumed Performance Level 10 percent savings on 12,334 MT CO_2e emissions from fleet (conservative estimate)

Reducing the city fleet's consumption of fuel is a near-term action that can directly yield GHG reduction benefits and cost savings for the city. Implementation of a centralized fuel and fleet management system along with route optimization software are key steps to reducing overall fuel costs and GHG emissions via improvements in fleet efficiency and VMT reductions. Over time, savings from improved fuel management and reduced VMT by city vehicles could enable scarce public operating funds to be re-allocated toward other GHG reducing activities.

A fuel management system provides fleet managers with an account of every gallon consumed and can help vehicle operators more accurately account for their vehicle's fuel usage. The ability to capture accurate data about fuel consumption and operation for each of the more than 1,600 municipal fleet vehicles[1] can empower fleet managers and operators to identify potential maintenance issues and inefficient vehicles that lead to wasted fuel. Standardized reporting that includes a fuel consumption baseline for each department, vehicle miles per gallon (mpg), miles travelled, number of maintenance problems, amount of fuel consumed, actual mpg compared to manufacturer mpg, etc. can provide city leadership with information for evaluating and improving fuel and vehicle performance. In addition, route optimization software helps fleet managers and dispatchers determine the most efficient vehicle paths based on timing needs, equipment allocation, workdays and service needs. The Northeast Maryland Waste Disposal Authority used a fleet optimization program to re-route 100 trucks for servicing approximately 230,000 households[2]. This route optimization effort saved 6 million dollars in avoided fuel, labor, maintenance and other operation costs.

1 Information from Baltimore Office of Sustainability as of 7/1/11 regarding fleet totals for DGS-Building, DGS-Fleet, DOT-Trans, DPW-SW, DPW-WWW, HCD, Health

2 Case study from Baltimore is described on website of one route optimization system vendor http://www.gbbinc.com/products/fleetroute/fleetroute_casestudies.shtml

ACTION	RESPONSIBILITY
Install fuel tracking system in each vehicle and fueling device for relevant department fleets.	Baltimore City DOT, HCD, Health, General Services
Install and utilize route optimization software in most relevant departments.	Baltimore City DOT
Prepare standardized, annual fuel consumption report for all city departments.	Baltimore City BOS

LUT STRATEGY 6 Support cleaner vehicles

While fuel tracking systems can promote efficient use of fuel, more significant carbon reductions can be achieved through replacement of conventional vehicles with alternative fuel vehicles including electric (EV), hybrids, compressed natural gas (CNG), flex-fuel and biodiesel and non-motorized options such as bicycles. Green fleet purchases can reduce long-term costs and risks of rising fuel prices and maintenance costs when compared to keeping older, less fuel efficient vehicles.

Electric vehicle charging station in Chicago (Source: Flickr User afagen)

LUT 6.A Support alternative fuel infrastructure and encourage adoption of alternative-fuel vehicles

Policy Mechanism Infrastructure

Time Frame Mid- to long-term

Performance Indicator Percentage of vehicles in Baltimore that are EV, CNG or other alternative vehicles; percentage of EV in city fleet

GHG Reduction 20,450 MT CO_2e

Assumed Participation Rate 1.3 percent of Baltimore vehicles to be EV by 2020

Assumed Performance Level 400 watt hours/mile for EV performance

Promotion of alternative vehicles must be accompanied by easily accessible fueling stations in order to increase the amount of alternative fueled vehicles used throughout the city. Alternative fuels are non-petroleum based fuels which have significantly lower GHG emissions than petroleum based fuels. Electric vehicles, compressed natural gas, ethanol and hydrogen are examples of alternative fueled vehicles available in the U.S. market and increasingly being used in municipal fleets.

Establishing electric charging stations and CNG fueling stations throughout the city will make it more attractive for residents, businesses and government fleets to invest in alternative fuel vehicles, thus promoting GHG emissions reductions by shifting from petroleum-based vehicle fuels. Furthermore, a network of alternative fuel infrastructure can reduce the city's exposure to oil market volatility, enabling management of fuel cost risks. The City of Raleigh, North Carolina has developed a series of partnerships among government and private sector entities to grow its alternative fuel infrastructure since 2002. Raleigh continues to expand the alternative fueling infrastructure and convert its fleet to alternative fuel compatibility.

Baltimore City is currently considering replacing 25 percent of its fleet with EV within three years. This conversion of 96 vehicles would demonstrate significant leadership from the city in reducing GHGs (approximately 280 MT CO_2e per year) and promoting energy efficient operational savings over time.

Support exists for growing the electric vehicle infrastructure in Maryland via the Maryland Energy Administration's Electric Vehicle Supply Equipment Tax Credit (EVSE). The EVSE provides a state income tax credit for businesses and residents for up to $400 for purchasing an electric vehicle charging station. In addition, the state's Motor Vehicle Administration is promoting the purchase of an EV by offering a one-time tax credit for up to $2,000 for the purchase of a qualifying electric plug-in vehicle[1]. The federal government also offers tax credits for the purchase of plug-in electric vehicles per Internal Revenue Code 30D and 30. A standard for new developments that could be adopted for alternative fueling infrastructure is from the U.S. Green Building Council's LEED program, which calls for 3% of parking spaces to be serviced by alternative fueling infrastructure (see LEED NC – SSc4.3).

1 *Visit www.mva.maryland.gov to learn more about this credit available through June 30, 2013.*

ACTION	RESPONSIBILITY
Convene partnership with utility and private sector for deploying alternative fuel infrastructure.	BOS/DGS/DOT/ Parking Authority/ Planning
Consider requiring a minimum percent or number of alternative fueling stations per car parking space provided for all new development in Baltimore.	BOS, HCD
Identify relevant subsidy, grant and cost-sharing opportunities.	BOS

LUT 6.B Promote fuel-efficient cargo handling in the Port of Baltimore

Policy Mechanism Infrastructure

Time Frame Short- to Mid-term

Performance Indicator Identify future reductions associated with fuel efficiency at the Port of Baltimore

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

The Port of Baltimore (POB) is composed of several publicly- and privately-owned terminals. The promotion of cleaner, more fuel efficient practices related to cargo-handling activities at the Port can reduce GHG emissions and lead to improved levels of local air quality. This measure includes working more closely with the Port of Baltimore's existing Clean Diesel Program that promotes the use of clean diesel technologies to reduce diesel emissions and their impact on human health.

The Maryland Port Administration (MPA), a state agency responsible for stimulating the flow of waterborne commerce through the Port of Baltimore, initiated a Clean Diesel Program in 2009 and has partnered with several government agencies and non-governmental organizations (NGOs) to significantly reduce air emissions at the Port. The program has already made significant progress by replacing, retrofitting, and upgrading several pieces of equipment including dray trucks, cranes, locomotives, watercraft, and cargo handling equipment.

The MPA is supportive of any efforts and partnership opportunities that will sustain the Port of Baltimore's Clean Diesel Program and will contribute to future emission reduction goals.

In 2012, the POB Clean Diesel Program established a dray truck replacement program that was funded by an Environmental Protection Agency grant to the Mid-Atlantic Regional Air Management Association (MARAMA). The MPA and the Maryland Department of the Environment (MDE) partnered with MARAMA to provide matching funds to increase the value of the program; the program is expected to replace 50 dray trucks that service the Port of Baltimore marine terminals. Continued efforts to support this and similar programs that contribute to ongoing emission reduction goals related to port activities are a goal of this proposed measure.

ACTION	RESPONSIBILITY
Work with the Maryland Port Administration and the Baltimore Port Alliance to expand strategies that reduce diesel emissions related to port activities including: • Evaluate new opportunities to support POB's Clean Diesel Program • Encourage the use of clean diesel technologies such as hybrids, electric vehicles, and certified clean-idle vehicles.	BOS, MD Port Administration, Baltimore Port Alliance

Potential Strategies for the Future (beyond 2020)

These strategies are recommended actions for inclusion in the CAP, but are thought not to be feasible for implementing prior to 2020 given anticipated economic and growth trends. However, changes in these trends may make this strategies more feasible for mid-term consideration.

- Invest in transit infrastructure Investments in transit infrastructure that increase service, reduce trip times, and expand the network will facilitate the use of public transit, reducing VMT. Coordination with MTA to enhance and expand transit infrastructure is essential. Transit improvements include: creating Bus Rapid Transit (BRT) routes, expanding MTA QuickBuses, providing GPS-based real-time transit information to riders, and implementing a signal priority system for bus routes.
- Expand Charm City Circulator Consider expansion of Charm City Circulator service to include more extensive route options and more frequent service.

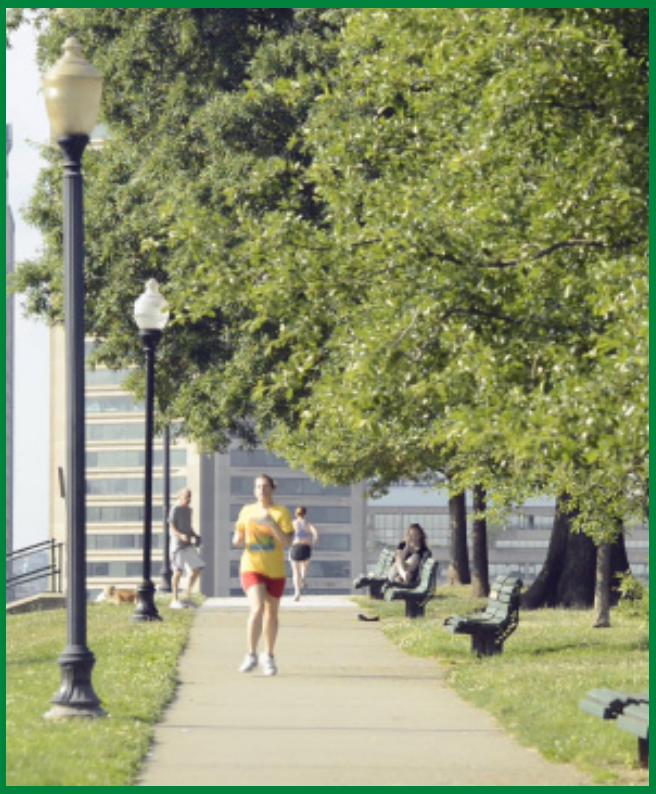
Charm City Circulator (Source: Flickr User Kurt Raschke)

GROWING A GREEN CITY

While the combined GHG emissions in Baltimore City from waste, water and green infrastructure accounts for only 4.9 percent of GHG emissions, actions to reduce GHGs in these sectors provide numerous quality of life benefits in addition to helping the city reach its GHG reduction targets.

A green city is characterized by efficient use of energy and water resources and by a visible and vibrant infrastructure of interconnected open spaces and natural areas (e.g., urban forest, greenways, wetlands, parks, forest preserves and native plant vegetation). Reduced generation of waste and promotion of material re-use are key activities for decreasing GHG emissions, both from the collection and transport of waste materials by truck and the release of GHGs as materials decompose. More efficient consumption of water can minimize the amount of GHGs generated through the treatment, distribution, pumping and use of water as it travels from reservoirs into homes and offices. Proper maintenance of environmental assets such as urban forests, greenways, wetlands and parks can lead to the absorption of GHG emissions of CO_2, natural management of stormwater, reduction of flooding risk, improvement of water quality, promotion of clean local air quality and provision of local climate control. Furthermore, green infrastructure such as street trees, parks and community gardens can promote pride in the city's landscapes and provide social and recreational benefits for city residents.

The total GHG reduction potential of the Growing a Green City (GGC) measures is estimated to be 38,935 MT CO_2e per year, or approximately 3 percent of total GHG reductions in the CAP.



Park in Baltimore (Source: AECOM)

Mercy Medical Center (Source: AECOM)

GGC STRATEGY 1 Divert waste from landfills

Greenhouse Gas (GHG) emissions related to solid waste result from personal consumption, waste disposal patterns and pre-consumer production. In Baltimore City, 3 percent of GHG emissions are associated with solid waste generation and disposal in landfills (approximately 209,315 metric tons of CO_2e in 2010). The Climate Action Plan proposes three waste strategies to reduce waste-related GHG emissions: develop a comprehensive recycling plan, reduce construction and demolition waste, and compost organic materials. In addition to saving space in landfills, increasing recycling rates reduces GHG emissions by supporting the creation of recycled materials that require fewer virgin raw materials. By processing existing materials to make new materials, recycling saves natural resources and reduces the GHG emissions associated with raw material extraction. Diverting waste from landfills can lead to GHG emissions reductions by reducing waste-collection truck travel. Waste diversion also can reduce the amount of methane produced by organic material decomposing in landfills.

The City of Baltimore Department of Public Works' Bureau of Solid Waste (BSW) is responsible for maintaining the cleanliness of the city and providing curbside trash and recycling pick up for single family residences and small businesses. The BSW delivers waste to the Quarantine Road Sanitary Landfill (QRSL), the Baltimore Refuse Energy Systems Company (BRESCO) waste-to-energy plant, and recycling centers. The BSW is not currently able to support recycling at large businesses. Entities not supported by the city recycling program contract private waste disposal services that also deliver waste to the QRSL, the BRESCO plant, and recycling centers.

The QRSL has a methane capture system that captures 100 percent of the methane produced by decomposing material. The BRESCO plant creates steam in the incineration process and uses the steam to power the plant, and when additional steam is available, it is distributed to downtown buildings and/or sold to the power grid. BRESCO also recovers ferrous metals from the ash residue and ships these off-site to be recycled.

Baltimore City's recycling and waste program, One PLUS ONE, implemented in 2009, changed the city from twice weekly trash collection and recycling collection to once weekly trash and recycling collection. The program successfully increased the city's recycling rate by 55 percent. Only single-family residences and small businesses can participate in One PLUS ONE. The city's Maryland Recycling Act (MRA) recycling rate under the state mandate was 27.01 percent in 2010, while the state recycling rate goal is 35 percent. The residential recycling rate was 15 percent.

Recycling in Baltimore (Source: Baltimore City)

The Bureau of Solid Waste publishes a Solid Waste Management Plan (SWMP) every ten years. The last SWMP, dated July 2002, included several strategies for diverting and managing waste. A comprehensive recycling plan (Measure GGC 1.A) will build on existing strategies by establishing recycling strategies for all building types and setting participation targets to meet waste reduction goals. The new recycling plan should be included in the SWMP update.

Construction and demolition (C&D) waste consumes significant space in a landfill, yet it is highly recyclable and reusable. By targeting the diversion of this waste, the city can increase the longevity of its landfills, while also capturing the embodied energy of existing materials (Measure GGC 1.B). Furthermore, C&D waste processing is considered by the Baltimore Office of Sustainability as a green industry with high job growth potential in Baltimore.

Organic material in landfills produces methane gas as it decomposes in the absence of oxygen (anaerobic decomposition). By diverting organic material from landfills and composting it on-site or at composting facilities under aerobic conditions, the city can reduce the production of methane gas, a greenhouse gas (Measure GGC 1.C). As consumers of goods and services, every city resident and worker generates waste and related GHG emissions. Individual consumer and behavior choices related to waste reuse, reduction and recycling determine personal contributions to city-wide waste generation. Increasing waste reduction behaviors and encouraging recycling can substantially reduce city waste generation and thereby reduce GHG emissions.

GGC 1.A Develop a comprehensive recycling plan

Policy Mechanism Strategic Plan

Time Frame Short-term

Performance Indicator Percentage of waste diverted from landfill/recycled

GHG Reduction Supporting

Assumed Participation Rate N/A

Assumed Performance Level N/A

A comprehensive recycling plan is being developed by the Bureau of Solid Waste (BSW) as part of the 10-Year Solid Waste Management Plan, which is aiming to increase the city's recycling rate from 27 percent to get closer to the state goal of 35 percent. It will include strategies for expanding the recycling service to more building types such as multifamily residential, developing residential and commercial composting, and implementing construction and demolition measures. The Bureau of Solid Waste already reaches out to promote and market recycling to all sectors of the city within the means and resources available to it and the CAP will support those efforts. The Office of Recycling is exploring joining EPA's WasteWise Communities program. A comprehensive recycling plan should prioritize existing residential consumers with a focus on waste diversion and recycling, advocacy for all waste reduction practices, as well as recycling and reuse efforts planned and initiated by the city.

ACTION	RESPONSIBILITY
Support the development of the comprehensive recycling plan (including composting and construction and demolition measures) within the 10-Year Solid Waste Plan.	Public Works /BSW/ BOS(Baltimore Office of Sustainability)
Work with the Bureau of Solid Waste to develop an outreach program to residents and businesses to enhance implementation of recycling program.	Public Works/BOS
Consider participating in the EPA's WasteWise program, which offers technical assistance to promote the recycling of municipal solid waste.	Public Works/BSW

GGC 1.B Reduce construction and demolition waste

Policy Mechanism Mandatory

Time Frame Short-term

Performance Indicator Percentage of C&D waste diverted from landfill

GHG Reduction 4,580 MT CO_2e

Assumed Participation Rate 100%

Assumed Performance Level 75% of C&D waste overall (e.g., masonry, metals, concrete, etc.), including 100% of wood waste

The City of Baltimore is considering the adoption of the International Green Construction Code (IgCC) to apply to all multifamily residential, commercial and institutional sector buildings. This includes a requirement to divert a minimum of 50 percent of construction and demolition waste from landfill for salvage or reuse (ranging from actual reuse of doors to reuse of rubble as fill for roads or foundations). The IgCC offers jurisdictions the option to raise the requirement to a higher percentage. For city-owned properties (the majority of which are single family residential and thus are not covered by IgCC) the bid specifications for construction and demolition projects need to be modified to require that all wood, masonry and brick are diverted from the landfill. Construction companies in the city already recycle and reuse some of the construction and demolition waste produced on job sites.

ACTION	RESPONSIBILITY
Obtain guidance and direction on changing bid specifications for city demolitions projects from the Department of General Services and the Department of Housing and Community Development.	BSW
Clarify how the city defines salvage goods and recycled goods.	BOS/HCD (Dept of Housing and Community Development)/DGS (Dept of General Services)
Modify bid specification for city demolition projects to require 75 percent of construction and demolition waste to be recycled or re-used.	BOS/HCD/DGS
Provide education and technical assistance to contractors and construction firms to help them meet the higher requirements.	HCD/DGS/BOS

GGC 1.C Compost organic material

Policy Mechanism Voluntary, Outreach

Time Frame Short- and mid-term

Performance Indicator Number of home composting units distributed through Baltimore program, tonnage of material received at composting facility in Baltimore (when created)

GHG Reduction 7,225 MT CO_2e (if implemented by 2015) assuming commercial and residential

Assumed Participation Rate 60% residential, 80% commercial by 2020

Assumed Performance Level 80% of food scraps and compostable materials diverted from the landfill

Compost bin (Source: Flickr User bikecrow)

There is no formal composting curbside collection program currently in Baltimore although homeowners have been encouraged in the past to install garden composting units. If carefully managed with the appropriate food and green scraps, residential composting can produce excellent fertilizer material and reduce methane producing waste from going to the landfill.

Implementing a city-wide composting program is currently challenging due to the lack of a nearby industrial-size composting facility. Smaller scale, local composting is still a valuable alternative given the lack of good quality topsoil in the city. The short-term goals are to focus on promoting household composting options that are suitably contained and rat-proof, to compile information about composting options currently available for businesses and institutions and to increase support for large scale food waste composting at commercial and institutional facilities. The long-term goal is to establish a large-scale composting facility that would accept residential organic waste close to the city.

ACTION	RESPONSIBILITY
Develop strategy for small-scale, household composting focusing on backyard units for composting and appropriate educational outreach and technical assistance.	BOS in consultation with BSW
Develop education and outreach materials for businesses and institutions regarding current composting options (consider partnering with B-CaUSE and other university and hospital sustainability and shared services groups in Baltimore).	BOS
Initiate pilot studies for identifying a longer-term composting site for receiving and processing large amounts of residential, commercial and institutional compost.	DGS/BOS/DPW (Dept of Public Works)

Note that while 100% methane may be captured at the landfill this usually translates to a 75% efficiency rate according to the EPA, so some savings could still be accounted for here, in addition to the co benefits of a reduction in tonnage that needs to be trucked for disposal and compost generated for soil improvement.

GGC STRATEGY 2 Improve water efficiency

Greenhouse gas (GHG) emissions related to drinking water result from the energy used to convey and treat drinking water. In Baltimore City, approximately two percent of GHG emissions are associated with wastewater and water (approximately 162,225 metric tons of CO_2e in 2010).

Treating, pumping and distributing water to the city through the miles of pipes laid beneath the city is an energy intensive activity, exacerbated by high leakage from old pipes. Leakage reduction in the water distribution system can contribute to city-wide water and energy efficiency (Measure GGC 2.A). Efficiency of the water distribution system can be enhanced in two ways. First, through building and individual user efforts that address water conservation by the user such as fixing leaking faucets, installing low volume showerheads and low-flow toilets in existing homes (Measure GCC 2.B). Second, by repairing and enhancing the water distribution system so less water is lost to waste through leaking pipes and old, energy inefficient pumps. The city's potential adoption of the International Green Construction Code (IgCC) and its new construction/major renovation provisions would ensure future build-out is water efficient; however, the IgCC does not include provisions for small residential buildings (Measure GCC 2.C).

Water main in Baltimore (Source: Flickr user Pam Broviak)

GGC 2.A Repair water supply infrastructure

Policy Mechanism Infrastructure

Time Frame Mid- to long-term

Performance Indicator Percent leakage rate

GHG Reduction 1,600 MT CO_2e

Assumed Participation Rate N/A

Assumed Performance Level 20 percent total system water loss by 2020

Baltimore City has an aging water conveyance system with current water loss estimated at 23 percent. Water loss is attributed to real losses from leakage and apparent losses due to metering errors and fire hydrant usage. Real losses can be addressed by rehabilitating or replacing water mains to reduce leaks. Reducing water leaks will make the entire water conveyance system more efficient at supplying water to residents and businesses throughout the city. Apparent losses are attributed to metering inaccuracies and will be reduced with implementation of the automatic metering infrastructure (AMI) program and the testing and calibration of master meters in treatment plants, pump stations and large consumers. The combined efforts of water main repair and effective metering should lead to a reduction in water loss. It is likely that the 23 percent water loss will be maintained or marginally increased for a number of years and long after the water main replacement program is ramped up to one percent per year and AMI programs are implemented.

ACTION	RESPONSIBILITY
Identify and prioritize list of cost efficient leakage repair opportunities.	BWW
Implement high priority water main repairs to reduce leaks.	BWW
Continue efforts to implement AMI program to install water metering devices to account for water loss.	BWW

GGC 2.B Improve water efficiency in existing small residential buildings

Policy Mechanism Incentive

Time Frame Short-term

Performance Indicator Number of buildings retrofitted

GHG Reduction 6,290 MT CO_2e residential

Assumed Participation Rate 20 percent showers, faucets and toilets, 70 percent dishwashers and 50 percent clothes washers replaced by 2020

Assumed Performance Level High-efficiency appliances

Since the majority of Baltimore City's building stock is residential, this measure targets existing homes by promoting incentives to replace fixtures and increase water efficiency. These incentives would be existing refunds or rebates administered by the Bureau of Water and Wastewater and other funded projects such as Project Lightbulb and Baltimore Energy Challenge (BEC). The projects could be expanded and aligned with the BWW to impact more homes and to expand the number of water efficiency measures promoted. Once water efficiency programs are implemented for residential buildings, as a next step the city can explore expanding the program to commercial buildings.

While reductions in water use will reduce the energy required to pump water, it will also result in reduced revenues for maintaining and operating the water conveyance infrastructure. The costs to maintain and operate the infrastructure are fixed; therefore, the BWW will need to investigate how to maintain revenue to meet maintenance demands, including the potential of large rate increases.

Support the Department of Public Works' efforts to replace residential water meters which will enhance billing accuracy. Water efficiency savings at the household level can help residents see results from water efficiency measures.

ACTION	RESPONSIBILITY
Develop an outreach campaign to promote existing incentives for homeowners to install water efficient fixtures.	BWW/BOS
Join the EPA's WaterSense program to gain technical assistance on outreach efforts, and tools and resources to promote water efficiency.	BWW
Assess how to maintain system revenues for meeting maintenance demands while also promoting efficiency.	BWW

GGC 2.C Improve water efficiency for new construction and major renovations of small residential buildings

Policy Mechanism Mandatory

Time Frame Mid-term

Performance Indicator Number of new developments and major renovations installing the higher water-efficiency measures

GHG Reduction 1,050 MT CO_2e

Assumed Participation Rate 100 percent toilets and 80 percent showers, faucets and appliances

Assumed Performance Level High-efficiency appliances

Although new development will contribute to a small proportion of the city's stock by 2020, it is still important to make sure that new buildings are built to an efficient standard. If adopted by the city, the IgCC will apply to major renovations and new construction of large buildings; however, since IgCC will not apply to the small residential sector the city may want to consider creating small residential water efficiency standards. This measure extends the IgCC water efficiency requirements to new residential construction and major renovations and uses the EPA's WaterSense program specifications for fixtures as guidance.

ACTION	RESPONSIBILITY
Obtain guidance and direction from the Department of Housing and Community Development regarding best approach to code changes to increase water efficiency.	HCD/BWW/BOS
Change plumbing standards to adopt the EPA's WaterSense program specifications for fixtures in small residential new construction and major renovations.	HCD/BWW/BOS
Join the EPA's WaterSense program to gain technical assistance on outreach efforts, and tools and resources to promote water efficiency.	HCD/BWW/BOS
Provide technical assistance, education and outreach materials for homeowners on water efficiency measures to consider prior to a major renovation.	HCD/BWW/BOS

GGC STRATEGY 3 Enhance the Urban Forest

Trees and other urban vegetation provide invaluable ecosystem services that benefit humans and other living creatures. The ecosystem services that are most important for the CAP are carbon sequestration (ability of trees to absorb carbon dioxide from the atmosphere, thus reducing atmospheric GHG concentrations) and local cooling. (Other services include providing a home for insects and birds, managing stormwater and improving air quality.) Trees and plants sequester or capture carbon from the air through photosynthesis by storing carbon in biomass and soils. Trees and other vegetation can make urban areas feel cooler (and reduce what is called the heat island effect) by shading buildings and large areas of asphalt. Cooling benefits from vegetation can be promoted by replacing surfaces, where feasible, like sidewalks or pavement that radiate heat with vegetated surfaces containing shrubs and trees. The heat island effect can cause increased air conditioning demands in buildings, and therefore increase GHG emissions as well as local health issues from air pollution and heat stress. By increasing the amount of trees and urban vegetation, this localized heating effect will be reduced. Increasing the number of street trees will also shade sidewalks and therefore encourage residents to walk rather than drive shorter distances through creating a comfortable pedestrian environment.

Baltimore City is known for its pioneering efforts to research, conserve and enhance urban ecology through several initiatives including the Baltimore Ecosystem Study and TreeBaltimore. The Baltimore Ecosystem Study is a long-term research study funded by the National Science Foundation and the Environmental Protection Agency to learn about ecosystem interactions in the Baltimore City region. The Baltimore Ecosystem Study has several ongoing projects that provide valuable research and data on soils, vegetation, habitats, watershed, and many other topics. TreeBaltimore, a Baltimore City Recreation and Parks program, "serves as the umbrella organization for all city agencies and private organizations in their effort to increase the tree canopy of Baltimore." TreeBaltimore's primary programs are the Free Tree Giveaway, Tree Neighborhood, Tree Acres, the Discount Coupon Program, and the Street Tree Program. In addition to all these initiatives, Baltimore has a Forest Conservation Ordinance, which protects existing forests during any construction or land development process and requires planting trees wherever existing forest is less than 15 percent on land development sites. In addition to ecological benefits, a 10 percent increase in tree canopy in Baltimore has been found to reduce crime by 12 percent (U.S. Forest Service and National Science Foundation, 2012).

The green infrastructure measure in this CAP seeks to reinforce urban forest programs by setting a goal to plant 75,000 trees by 2020. While increasing urban canopy is a goal that is also identified in the Sustainability Plan, Measure GGC 3.A seeks to increase the absolute number of trees because each tree sequesters carbon.

Canton Waterfront Park (Source: Baltimore City)

Baltimore Sustainability Plan Quantification
Growing a Green City Activities

In addition to the new Growing a Green City measures outlined in this chapter, there has been progress made through activities from the Sustainability Plan. Reductions from the activities that will contribute to the overall reduction have been estimated and are included below:

- Water appliance upgrades from new commercial buildings due to Baltimore City Green Building Standards – 3,255 MT CO_2e
- Climate appropriate planting and irrigation retrofits from existing landscaping and new landscaping requirements – 5,910 MT CO_2e
- Landscape waste diversion improvements – 1,425 MT CO_2e
- Water appliance upgrades during commercial building retrofits – 2,710 MT CO_2e

Total savings estimated from Sustainability Plan impact – 13,270 MT CO_2e

GGC 3.A Protect and enhance Baltimore's tree canopy and number of trees planted

Policy Mechanism Mandatory (tree protection ordinances), Voluntary (TreeBaltimore)

Time Frame Mid- to long-term

Performance Indicator Percent increase in urban canopy

GHG Reduction 4,920 MT CO_2e

Assumed Participation Rate 75,000 trees

Assumed Performance Level N/A

This measure requires the city to strengthen its existing tree programs by adopting an updated city canopy protection ordinance that includes key considerations such as maintenance and tree removal and replacement guidelines applicable to all lands in Baltimore. The city has several tree planting programs that would be strengthened by developing a comprehensive urban forestry plan that unites programs under one vision.

By coordinating existing ordinances the goals are to: protect trees, increase the number of trees, and improve the health of trees.

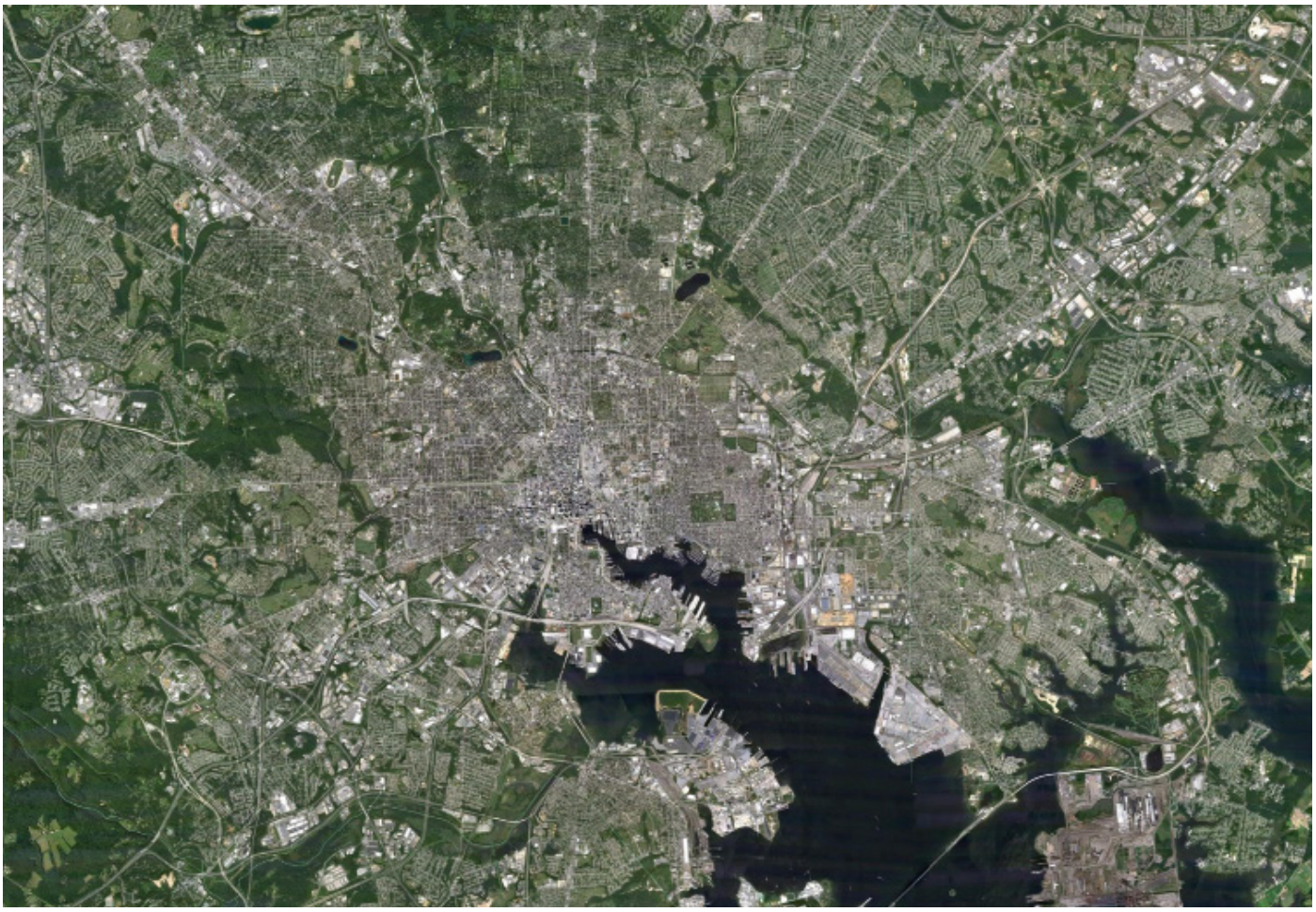
The city is developing a stormwater user fee that will charge landowners a fee based on the amount of impervious surface on their property. Landowners can receive credits for implementing environmental site design practices on their property. Any tree planting incentive should align with the stormwater credit system as related to the stormwater user fee. Tree planting standards should be established in concert with the BWW to establish offset distances from water and wastewater mains because tree roots can cause significant damage to mains. Tree planting standards should be shared with all agencies engaged in tree planting including the Baltimore City Departments of Public Works, Transportation, General Services and Recreation and Parks and the Maryland Department of Natural Resources' Tree-Mendous Maryland Program. Tree-Mendous helps citizens restore tree cover on public lands, including parks, community open spaces, rights-of-ways, government facilities and school grounds.

Tree in Baltimore (Source: Flickr User Sam-Lehman)

ACTION	RESPONSIBILITY
Create a comprehensive urban forestry plan.	BCRP
Strengthen the tree protection ordinance by developing and seeking legislative passage of an enhanced tree protection ordinance. Build upon the existing legislation.	BCRP
Provide tree-planting and canopy protection incentives to landowners through the stormwater user fee and credit system, draft Landscape Ordinance, and TreeBaltimore program.	BCRP/DOP/DPW
Ensure that all agencies involved in tree planting and tree management receive technical assistance, education and outreach as needed for selecting tree species and protecting existing trees.	BCRP/NGO Partners

Chapter 4

Climate Adaptation



Aerial of Baltimore City (Source: Google Earth)

Climate Adaptation

Baltimore, like many cities across the country, has been putting in place policies and programs for many years focused on decreasing GHG emissions – and this Climate Action Plan (CAP) is the city's latest effort. However there is now rising awareness and acceptance that we need to learn to live with or adapt to a changed climate. While GHG mitigation initiatives will continue to be essential to stabilizing the climate in the long-term, the climate system will take time to respond to GHG reductions. This means that the GHG concentrations already in the atmosphere commit us to a likely range of climate change impacts in the near future.

The City of Baltimore therefore believes that it needs to put in place climate adaptation measures to help its residents, city operations and businesses to adapt to actual or expected impacts of climate change. Some of the possible effects of climate change in Baltimore include: increased number of extreme weather events such as longer and more frequent heat waves and coastal storms, heavier and more frequent rainfall particularly in the winter and sea level rise (increasing the impact of the flooding already experienced regularly in the city). These effects could have a significant impact on property, public health and safety. This chapter reviews the expected climate impacts, the adaptation activities in place at the federal and state levels and existing climate adaptation related projects in the city. It also summarizes the climate mitigation activities described earlier in this document that have adaptation impacts and finally outlines the broad priorities identified by the Baltimore CAP's Adaptation Working Group for future adaptation efforts in Baltimore.

Baltimore row houses (Source: Flickr User Baltimore Heritage)

What might the climate be like in the future in Baltimore?

A range of studies have looked at what the projected climate change impacts could be for the Mid-Atlantic Region, the State of Maryland, and Baltimore City.

Higher Temperatures

In Maryland, temperatures are projected to be warmer during every season, with the largest change in average temperature occurring during the summer. Over the past 100 years, overall average temperatures have increased by 1.8˚F, while winter average temperatures have risen by 3.6˚F[1]. Annual average temperatures in Maryland are projected to increase by 3-8° F by the end of the century[2] depending on how successful we are at slowing our rate of GHG emissions. Extended heat waves and temperature extremes are likely to be more frequent and longer lasting. In urban areas of Maryland it is projected that temperatures exceeding 90° F will occur between 80 and 120 days annually by the end of the century. In the late 20th century, the average was approximately 40 days per year. The number of days projected to exceed 100° F in urban areas of Maryland by the end of the century is between 15 and 35 days, increasing from less than five days in late 20th century[3].

The impact of this level of heat could be more severe in urban areas where there are extensive areas of dark colored asphalt and buildings, with little green space or tree coverage. This is commonly called the 'heat island effect'. Baltimore already has a Code Red Heat Alert Plan in place, which establishes a coordinated approach to providing cooling relief to vulnerable populations in Baltimore City during periods of severe heat (greater than 105°F) during the summer months. Heat stress (heat cramps, fainting, heat exhaustion and heatstroke) and increased respiratory problems (such as asthma from poor air quality) are most likely to be suffered by the young and the old during heatwaves. It is likely that the number of Code Red or Severe Code Red days (when the temperature is greater than 110°F) will increase due to climate change.

Sea Level Rising and Flooding

1 DRAFT Climate Change in Maryland: A Resource for Educators Concept Development for MADE CLEAR (Feb 2012), National Science Foundation
2 Accessed 7 June 2012, http://www.umces.edu/sites/default/files/pdfs/global_warming_free_state_report.pdf Global Warming and the Free State Comprehensive Assessment of Climate Change Impacts in Maryland, based on IPCC scenarios.
3 http://www.umces.edu/sites/default/files/pdfs/global_warming_free_state_report.pdf

It is projected that sea levels will rise by 24-48 inches[1] along the coast in Maryland over the next century. Sea level rise will cause the erosion and retreat of shorelines and the inundation of about 180 square miles of presently dry land. Most of the land subject to inundation is located in the lowest lying parts of the state, especially along the Chesapeake Bay side of the lower Eastern Shore. However, portions of Baltimore County and other counties in Maryland west of the Bay are also susceptible. The city of Baltimore is vulnerable to increased flooding and the gradual submergence of low-lying lands. While only 3 percent of the land in Baltimore is in the coastal floodplain, this land includes the Inner Harbor and the Fells Point Historic District. The repair and replacement costs due to flooding in these areas would be significant due to the important road infrastructure, business and residential neighborhoods located there. Sea level rise also has the potential to affect the water levels of tributaries upstream of the harbor and the Bay. Rising water levels in the Bay can push up into the tributaries raising the baseline flow level and perhaps leading to more frequent inundation of adjacent floodplains and riparian buffers. Stormwater runoff patterns can also be altered as existing floodplains and stormwater basins may receive additional flows and can reach capacity sooner due to greater frequency and durations of extreme storms in addition to rising sea levels. Increasingly, saline waters from sea level rise will advance upstream and force some species to move to the upper reach of small header streams, thus increasing the extinction risk of endangered species such as the dwarfwedge mussel[2].

In the fall of 2003, Tropical Storm Isabel brought rain, wind and flooding to Central Maryland (insurance property damage totaled approximately $410 million[3] in Maryland). Baltimore was greatly affected by the storm surge that flooded parts of the Inner Harbor, Fells Point and other waterfront neighborhoods with up to eight feet of water. With sea level rise, the impact of such events would increase.

Precipitation and Storms

In Maryland, annual average rainfall is projected to increase by roughly 20%, and there will be more frequent and intense storms. In particular, major coastal storms are predicted to be more intense and more frequent. By the century's end, 5-15 percent more late-winter storms may develop in the Northeast as storm systems move further north in response to warmer ocean surface temperatures. It is likely that hurricanes will also become more intense, with increases in tropical sea surface temperatures. More intense storms generally produce greater storm surges, increasing flooding

1 Accessed June 7, 2012, http://www.mde.state.md.us/assets/document/air/climatechange/chapter3.pdf

2 DRAFT Climate Change in Maryland: A Resource for Educators Concept Development for MADE CLEAR (Feb 2012), National Science Foundation

3 Accessed June 7, 2012, http://www.nhc.noaa.gov/2003isabel.shtml

Back River Wastewater Treatment Plant (Source: Flickr User bjorn means bear)

risks, high winds and land saturation, causing damage to property. Storm damage, such as fallen trees on roads or road surfaces collapsing, can also impact short-term emergency response and longer-term movement of people and goods.

Severe flooding has occurred in Baltimore for over 200 years and records show major floods have been regularly documented from the early 19th century through the 20th century. Baltimore is particularly at risk from storm events due to the fact that there are four primary[1] watersheds within the city, and each of these watersheds and associated tributaries has the potential to overflow its banks. However, many more incidents are the result of flash flooding from sudden, short-lived rainstorms and localized flooding resulting from poor drainage and storm water management issues. Each time a flood disaster has occurred, businesses have been disrupted or destroyed, homes damaged and people's lives endangered. These flood events will become more and more frequent in the future.

How could this affect life in Baltimore?

Infrastructure and Urban Systems

Climate change will cause increases in summer temperatures which will require increased use of electricity for cooling. The balance of energy supply and demand will change particularly in the summer if more people turn on air-conditioning during longer, hotter summer months. This increased demand for power is already causing demand to outstrip supply and cause power brown outs, such as in the summers of 2011 and 2012 that had highs of 105°F and 104°F in downtown Baltimore. This risk is compounded during a heat wave, particularly for those managing their heat stress with air-conditioning. Climate change will also increase the severity and frequency of storms which will place additional stresses on the electricity delivery system which may result in increased disruptions in service even as people rely more on the cooling energy that electricity provides. Overheating of MARC train lines and delays or cancellations already affect commuters returning home to Baltimore from Washington, D.C.

Uncontrolled run-off from big rain storms has the potential to damage water and sewage treatment due to over flows at pumping stations, which can threaten recreational waters, aquatic life and contribute to fish kills, as occurred in May 2012, affecting businesses and restoration goals. Water quality and treatment costs could increase as more intense storms drive more organic matter, sediment and saltwater into reservoirs. A positive is that Baltimore City's water-supply system may be sufficient to meet demands under the projected climate change as greater winter-spring precipitation will increase the likelihood that reservoirs will be full heading into the drier summer periods, resulting in protection from water-supply shortages for areas served by the reservoirs. One of the city's most severe droughts in 2002-2003 saw groundwater and stream flows set all time lows[2]. However, water use restrictions and higher than increased snow melt flows restored reservoir levels to normal conditions.

The increased frequency and magnitude of floods in Baltimore's four watersheds, the Gwynns Falls, Jones Falls, Back River and Baltimore/Direct Harbor has implications for flood protection and the design of treatment plants, dams and bridges so the impacts of increased frequency of flooding can be avoided. Flooding can also affect roads, and even small flooding events can disrupt public transportation, upon which a large percentage of Baltimore residents depend. Power outages due to storm damage can also worsen transportation delays and put at risk those who are dependent on electricity for health needs. Big rain storms can also affect individual homeowners through water damage from leaking roofs and windows and localized flooding of basements or ground floors.

Keeping the appropriate water depth is a critical aspect of port maintenance, and the Port of Baltimore dredges its waterway regularly to keep the flow of goods unimpeded. However, increased levels of runoff upstream from flooding could increase the levels of trash and sediment that are deposited in the Baltimore Harbor. This could cause dredging operations to become both more costly and environmentally damaging (i.e., increased pollution in water and in the harbor's sediment can negatively impact the area's fisheries).

Commercial fishing and manufacturing are dependent on reliable access to ports from land and sea. Steadily rising sea levels and sudden sea level increases could disrupt port access and economically impact Baltimore's shipping, fishing and manufacturing industries. The increasing rate of shoreline erosion resulting from sea level rise could weaken bridge support systems, limit access for maintenance and deteriorate low-lying roads.

Human Health

Respiratory illnesses may increase due to more ozone formed in urban areas where there is extensive concrete and asphalt cover under prolonged, high temperatures. This includes increased incidence of asthma and other respiratory ailments. A Code Red Heat Alert for example, is currently also issued when poor air quality is associated with a 95°F temperature.

Increased precipitation can cause public health impacts. A study from the Johns Hopkins School of Public Health

1 *City and County Watershed report- see Watersheds Background on page 1- http://resources.baltimorecountymd.gov/Documents/Environment/Annual%20Reports/2010watershedsreportbookmarked.pdf*

2 *Maryland Department of Environment Press Release. March 20, 2003*

shows a positive correlation between higher-than-average precipitation events and outbreaks of waterborne diseases[1]. Climate change might affect the exposure of Marylanders to pathogens such as the West Nile virus, but precautions and treatment could manage this risk[2].

The Baltimore Harbor will likely be faced with higher risks of harmful algal blooms and resultant fish-kills affecting recreational fisheries and impacting nearly all businesses along the water. A higher frequency of sewer overflows associated with more intense storms will threaten those living near the overflows as well as domestic animals. Increasing storm surges and sea level rise will threaten areas where industrial chemicals are contained and/or manufactured, potentially threatening human health, particularly in low-income neighborhoods. Greater intensity runoff events can increase particulate and chemical concentrations in aquifers used for drinking water[3].

What is happening at a federal and state level?

Federal Adaptation Activities

Baltimore is not acting alone in thinking about climate adaptation. In October 2009, President Obama signed Executive Order 13514 (Federal Leadership in Environmental, Energy, and Economic Performance), which requires each federal agency to "...evaluate agency climate change risks and vulnerabilities in order to manage the effects of climate change on the agency's operations and mission in both the short and long term." Under the requirements of this order, federal agencies are incorporating consideration of climate change adaptation into their operations, programs and policies.

The Interagency Climate Change Adaptation Task Force was formed in spring 2009 in response to the Executive Order and is tasked with developing recommendations on how the policies and practices of federal agencies can be made compatible with and reinforce a national climate change adaptation strategy.

The U.S. Global Change Research Program released the National Global Change Research Plan 2012-2021: A Strategic Plan for the U. S. Global Change Research Program in April 2012, which "will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change." The Plan will be implemented through the next decade by the collective efforts of 13 U.S. government agencies that collaboratively help the nation better understand global change and its impacts. In 2011, the National Academies of Sciences released a report on America's Climate Choices. These activities show the seriousness with which potential climate change is being considered at a federal level. Further activities are listed in the Appendix F.

State of Maryland Adaptation Activities

The State of Maryland is also active in thinking about how to adapt to climate change, given that Maryland is one of the more vulnerable states to the potential impacts due to its extensive tidal shoreline (3,100 miles). It will be important for Baltimore to continue to engage in state level discussions regarding adaptation, given that many adaptation strategies need to be implemented at a regional level. In April 2007 Governor Martin O'Malley signed Executive Order 01.01.2007.07 establishing the Maryland Commission on Climate Change. The Commission created four Adaptation and Response Working Groups (ARWG) to develop the adaptation portions of the state's Climate Action Plan. With a focus on sea level rise and coastal storms, the four groups were: Existing and Future Built Environment and Infrastructure; Future Building Environment and Infrastructure; Human Health, Safety and Welfare; and Resources and Resource-based Industry.

The Phase I Strategy details the actions necessary to protect Maryland's future economic well-being, environmental heritage and public safety in the face of sea level rise. The Phase II Strategy for Reducing Maryland's Vulnerability to Climate Change outlines strategies to reduce Maryland's vulnerability to the impacts of climate change, including increased temperature and changes in precipitation within the following sectors: human health, agriculture, forest and terrestrial ecosystems, bay and aquatic Environments, water resources, and population growth and infrastructure. This Phase II Strategy provides the basis for guiding and prioritizing state-level activities with respect to both climate science and adaptation policy within short- to medium-term time frames. State agencies will use both strategies to guide and prioritize state-level activities with respect to both climate science and adaptation policy. The final implementation strategies for the state will be incorporated into the Greenhouse Gas Emissions Reduction Plan, to be finalized by the end of 2012[4].

1 Curriero, F.C., Patz, J.A., Rose, J.B., Lele, S. 2001. The Association Between Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948–1994. American Journal of Public Health 91(8): 1194-1199.

2 Global Warming and the Free State. Comprehensive Assessment of Climate Change Impacts in Maryland. July 2008. The mortality due to vector-borne and non-vector borne diseases in the United States is low because of public health precautions and treatment.

3 Climate Change Impacts on Maryland and the Cost of Inaction. A Review by the Maryland Commission on Climate Change. 2008.

4 See MD GHG reduction plan next steps in this document; http://www.mde.state.md.us/assets/document/Air/ClimateChange/AppendixE_Adaptation_Response.pdf

How is the City of Baltimore approaching adaptation?

Baltimore is soon to update its All Hazards Mitigation Plan (AHMP) in order to continue to get funds from the federal government for emergencies and to enable property owners and tenants in Baltimore to buy flood insurance through the National Flood Insurance Program. The AHMP provides a detailed inventory of natural hazards, conducts a vulnerability analysis and recommends actions and strategies to mitigate hazards. (A Federal Emergency Management Agency(FEMA) approved plan must be current and adopted in order to receive hazard mitigation assistance from FEMA.) The city intends to use data and community input from the AHMP as the foundation for creating a Baltimore Climate Adaptation Strategy (note that the research and subject breadth for the Baltimore Climate Adaptation Strategy will go beyond that needed for the AHMP).

The Baltimore Climate Adaptation Strategy will coordinate with the AHMP to allow for more in depth public dialogue, support and recommendations for necessary actions. The overall goal of the combined AHMP and Baltimore Climate Adaptation Strategy is to provide clear guidance to city government and its citizens to develop a unified strategy for both hazard mitigation and climate change adaptation that supports Baltimore's sustainability and resilience.

Process for updating the AHMP and developing a Baltimore Climate Adaptation Strategy

1. Use AHMP public outreach and data analysis process (funded through Maryland Emergency Management Agency (MEMA) grant) to identify existing hazards and associated vulnerabilities. This process will include stakeholders from both public agencies and private organizations that are focused on climate change and climate adaptation.
2. Identify climate change impacts from existing hazards and associated vulnerabilities using AHMP information as a foundation.
3. Identify key vulnerabilities through community workshops and gather further data analysis and study.
4. Select between two and four hazard mitigation/ climate adaptation actions to address.
5. Create implementation plans for these actions, as well as recommendations for further action and funding strategies for remaining items not identified for immediate action.

What measures in the CAP have adaptation benefits?

Many measures outlined in the Climate Action Plan have multiple co-benefits, in addition to greenhouse gas reduction benefits such as reduced water and energy use, improved water quality, and cost savings. An important co-benefit is climate adaptation. The mitigation measures listed below, and described in more detail in Chapter 3 of this document, have beneficial climate adaptation impacts as well as GHG reductions.

Energy Savings and Supply Measures

- Energy Conservation All measures in the Climate Action Plan that save electricity will help protect Baltimore from rolling brown outs or outages associated with heat waves or storm damage.
- Energy Supply All measures that encourage distributed or localized energy generation (e.g., building-integrated photovoltaics, solar water heating systems or combined heat power) will also help protect Baltimore from rolling brown outs or outages associated with heat waves or storm damage, by reducing Baltimore's draw on the grid.

Land Use and Transportation

- Mixed-use development All measures that promote walkable, mixed-use neighborhoods will ensure residents can walk to access daily needs even in an emergency situation when flooded roads may cut off communities. This will also help address issues of food supply.

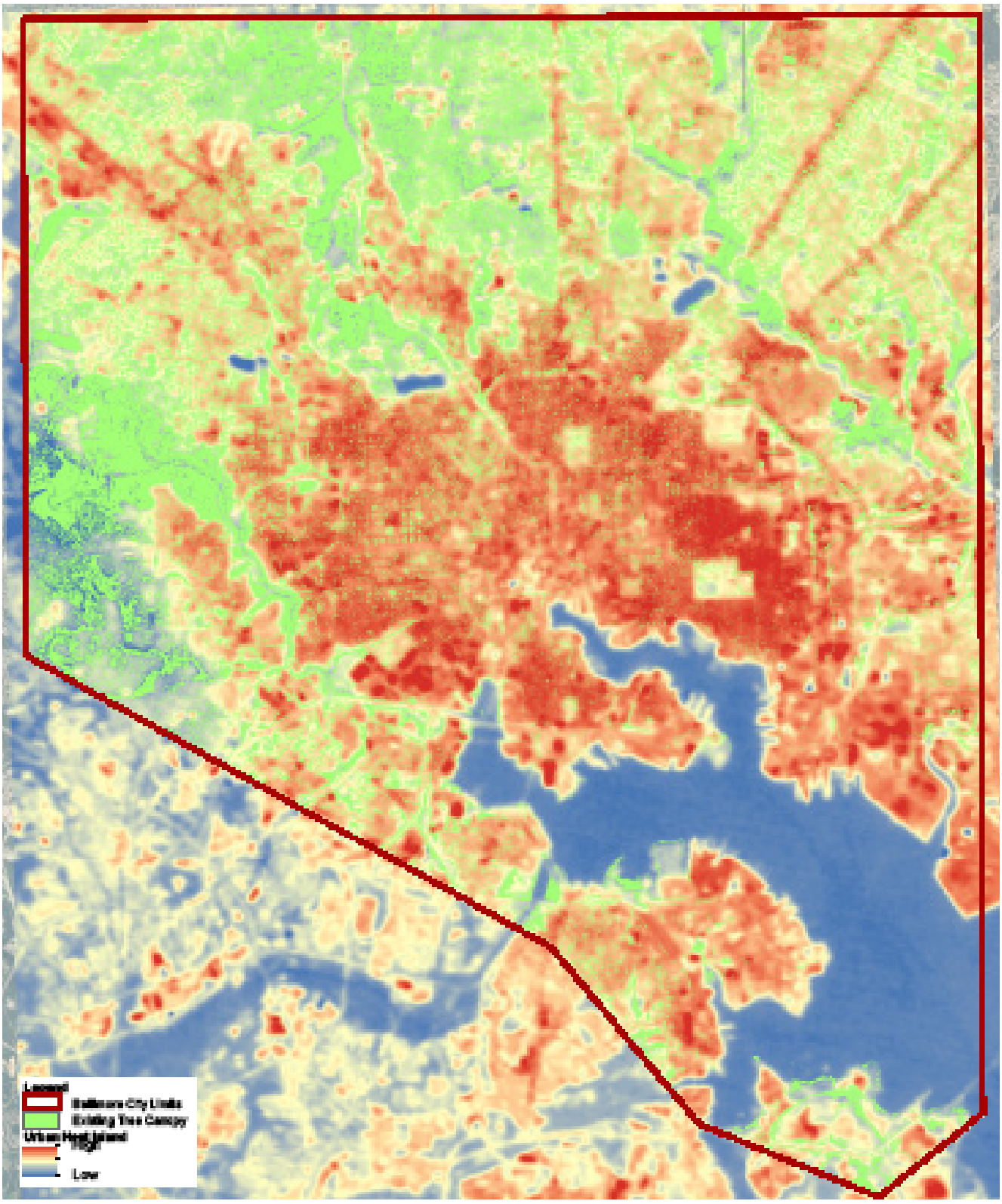
Growing a Green City

- Urban forest, orchards and riparian buffers Increasing the extent of the tree canopy and improving its long-term health will help slow storm water flow during heavy storms both due to the actual tree canopy area and increase in permeable area around the tree roots. An increase in Baltimore's urban forest will also help to decrease the heat island effect and improve air quality, both of which are expected to worsen in the future.
- Water conservation Saving water through residential, business and city government efficiency measures as well as minimizing leakage and water loss through conveyance will help to reduce energy demand and protect Baltimore from outages and brownouts. This will also help with issues related to extended droughts.

Targeting Adaptation Strategies

Data about a geographical area can help identify populations most likely to be vulnerable to climate change impacts. The urban heat island effect is worst in areas without green space or tree canopy coverage, as shown

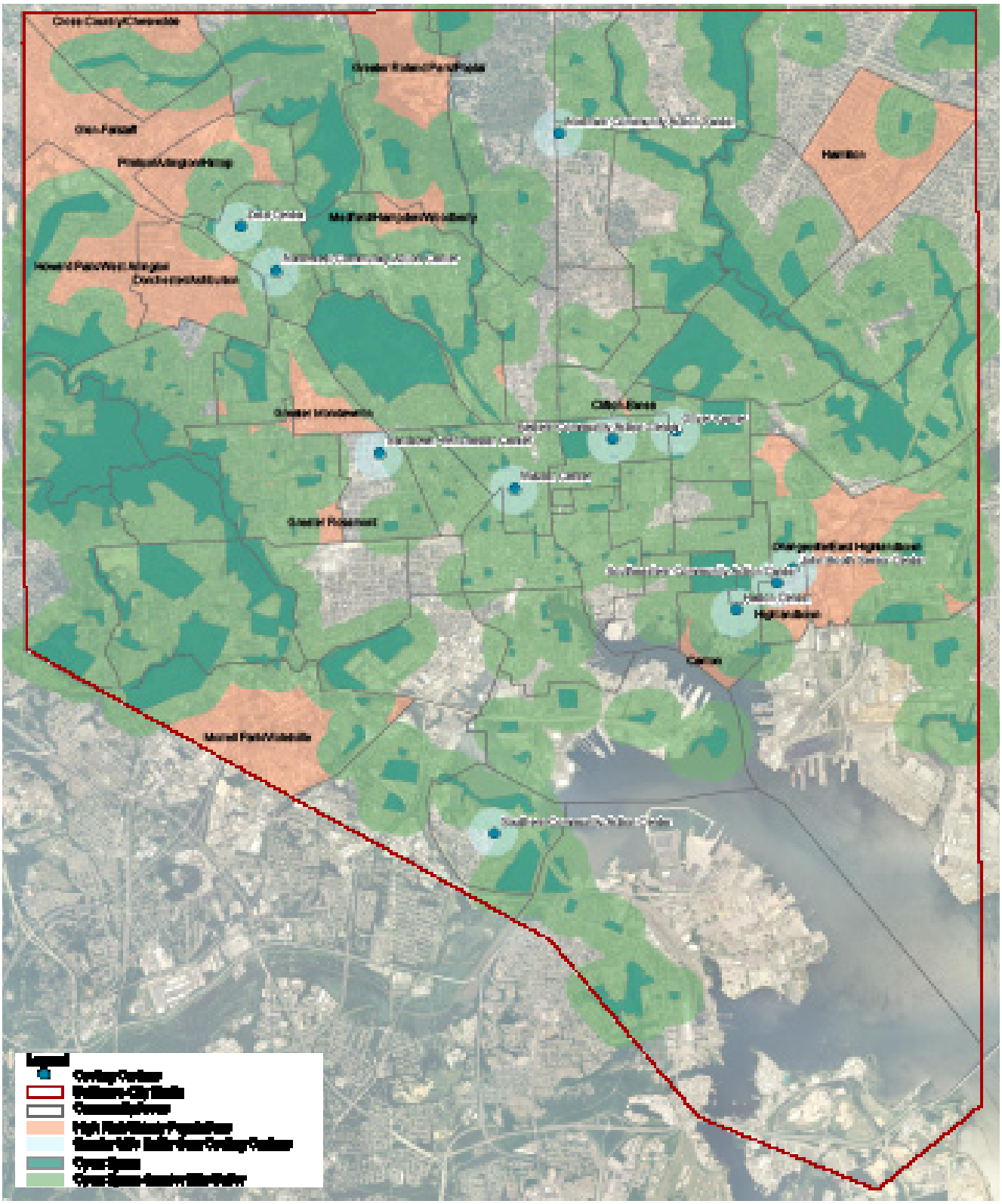
Figure 6 Tree Canopy and Urban Heat Island Effect Map



Source: AECOM 2012

in Figure 6, and this effect will be amplified during a heat wave. By mapping where vulnerable populations live (such as the elderly) alongside their access to areas of green space and existing cooling centres, as shown in Figure 7, the city can focus adaptation strategies on those most at risk.

Figure 7 Most Vulnerable Elderly Populations Map



Source: AECOM 2012

Adaptation Priorities for Baltimore

Given that the city will be initiating a comprehensive AHMP update and Baltimore Climate Adaptation Strategy in the fall of 2012, the Adaptation Working Group applied its expertise to identifying possible actions to be considered for the Baltimore Climate Adaptation Strategy and update of the AHMP. The State Adaptation Strategy should be used to guide this process, both in terms of identifying the climate impacts and consequences. The priority areas and actions are summarized below.

Prioritize vulnerability and risk assessments

- Carry out vulnerability assessments of critical infrastructure in the city by identifying the likely exposure, sensitivity and adaptive capacity of the asset to climate change impacts of sea level rise, increased precipitation, etc.
- For the most vulnerable assets, evaluate the likelihood and consequence to the city of those assets being impacted
- For the most vulnerable and at-risk assets, set priorities for adaptation strategies
- Develop criteria for choosing among adaptation options and strategies. Consider as a priority those options that have multiple benefits, in addition to adaptation, such as the ability to reduce greenhouse gas emissions and increase the overall sustainability and livability of Baltimore

Assess potential health threats and the sufficiency of Baltimore's response capacity, including:

- Improve the clarity, granularity (i.e., Baltimore specific data or extrapolation from data for a broader region) and availability of health and population data
- Analyze health and population data along with other information (e.g., land use, air quality, water quality)
- Evaluate impacts to food and water safety and availability
- Assess vulnerability of the elderly and young to extreme weather events, particularly heat waves, and identify where those populations are (building on the Code Red Heat Alert Plan and Response)
- Identify potential barriers to effective emergency response
- Identify the precautions and treatment that could manage the risk of exposure to pathogens, such as the West Nile Virus[1].

1 *Global Warming and the Free State. Comprehensive Assessment of Climate.*

Integrate climate adaptation into planning processes (to start in the AHMP update)

- Align with efforts at the state level. Consideration of adaptation should be integrated into all capital planning projects (to ensure a review of all plans, policies and investments with information about predicted climate change impacts) including:
  - Screening all projects for sea level rise and storm surge impacts, establishing design guidelines to mitigate for sea level rise if project will fall in future inundated zone
  - Making changes to Baltimore City Flood Plain Ordinance to address sea level rise and storm surge
  - Making changes to Baltimore City Comprehensive Master Plan to address sea level rise
  - Making changes to DOT/DPW/BCRP plans for infrastructure projects to address climate impacts
  - Establishing design guidelines for buildings and infrastructure that seek to mitigate and accommodate anticipated higher temperatures and potential increases in flood frequency
- Support community engagement in planning and emergency response decisions
- Integrate adaptation strategies into energy and other building and zoning codes (designing for longer hotter summers, etc.)
- Create and adopt a conservation design ordinance and regulations that preserve existing and future open space, wetland buffers, and riparian buffers to restore and enhance climate protection from flooding or sea level rise, promote biodiversity conservation and clustering/contiguity of spaces, encourage environmentally sensitive development and allow for species preservation and migration. (Note that mitigation credits could be used to focus on areas that increase resilience to climate impacts, such as sea level rise.)
- Expand the amount of open, vegetated and wetland spaces in the city to improve the long-term health of the tree canopy, forests and meadowlands by providing relief from heat island effect, which also provides a mitigation co-benefit of carbon sequestration
- Carry out engineering research into specific improvements that should be incorporated into the Baltimore Capital Improvement Program
- Ensure that the Reservoir Watershed Management Plan addresses such potential climate change effects as water supply and drought preparedness, variation in precipitation, water quality, flood management and storm drainage, riparian and aquatic ecosystem

enhancement, environmental flows, changes in runoff patterns, changes in customer demand and sea level rise effects on water supply, storage and distribution infrastructure

Play an active role in regional adaptation efforts

- Participate in discussions on climate adaptation and resilience issues with the state and adjacent jurisdictions to ensure new mapping, research, etc. can be built upon by the City of Baltimore
- Actively collaborate with Baltimore County and Anne Arundel County on joint climate adaptation programs and projects
- Focus regional issues on storm water, flooding and open space systems

Develop a Communications Plan

- Develop a communications plan and implement activities such as workshops, webinars and electronic communications to increase the awareness of city management and front-line city staff about the local impacts of climate change and adaptation
- Develop a public communications strategy regarding existing and future risks, particularly in relation to property and public health. Include for example the creation of community guidelines for low cost home improvements and actions that can be voluntarily taken to increase safety, reduce heat island effects and reduce damage from flooding
- Ensure that the Baltimore Climate Adaptation Strategy lends itself to continual public input, information, transparency and provides the foundation for a strong working relationship

Chapter 5

Monitor and Evaluate

Baltimore City Hall (Source: AECOM)

Climate Committee

The CAP was developed through a collaborative effort involving stakeholders from all sectors. The Climate Action Plan Advisory Committee looked at several aspects when developing the measures for the CAP, including how these measures would be implemented, monitored and evaluated.

The CAP, like any plan, will not have its intended impact, and be successful in helping to achieve greenhouse gas reductions, unless it is well implemented. As noted in the CAP, responsibility for implementation falls to numerous agencies and organizations, across many sectors, and will require oversight and strategic direction to ensure implementation. The Climate Action Plan Advisory Committee recommends that a Climate Committee be formed as a part of the Commission on Sustainability, to assist the Office of Sustainability in its efforts to implement, monitor and evaluate the CAP.

In addition, because climate change will continue beyond the CAP time frame (2020), the Climate Committee will also provide a continuous look to the future, and will examine additional long-term measures that the City should take to further reduce greenhouse gas emissions and to curb the continuing effects of climate change.

The Climate Committee will:

- Prioritize the measures in the CAP
- Act as a facilitator
- Provide guidance for legislative priorities
- Develop CAP metrics, with the Office of Sustainability
- Provide regular updates to the Commission on Sustainability
- Participate in state-wide climate communications and other efforts related to climate change.
- Support the incorporation of CAP metrics into the Annual Sustainability Report
- Research funding opportunities for implementation
- Work with the Office of Sustainability to ensure a full greenhouse gas emissions inventory is completed every three years
- Propose long-term greenhouse gas reduction measures -- beyond the scope of the CAP (2020) – as necessary
- Develop a plan for future revisions and updates to the CAP
- Create an analytic framework to evaluate the social and economic benefits and impacts of the Climate Action Plan

The Climate Committee will be comprised of members of the Commission on Sustainability, staff from the Office of Sustainability, staff from key city agencies, as well as several citizen members representing various sectors.

The Climate Committee will not be solely responsible for the implementation of the Climate Action Plan. It will work with the Commission on Sustainability and the Office of Sustainability to bring together, as necessary, the large number of partners needed to implement the CAP. Like Baltimore's Sustainability Plan, it will take an effort on everyone's part to ensure that we are successful in achieving our goal of 15 percent reduction by 2020.

Economic Analysis

As stated in the City of Baltimore's Sustainability Plan, sustainability is often viewed as a three-legged stool, comprised of social equity (people), environmental stewardship (planet), and economic health (prosperity). These three "legs" work in concert to provide an even foundation for the quality of life for Baltimore citizens. All three need to be strong, and are essential to the decision making lens of sustainability.

Baltimore's Climate Action Plan (CAP), and the strategies and measures outlined within, is a strong base for which the City can address greenhouse gas emissions and work to achieve reduction targets. It is fundamental when looking to implement the suggested measures in the CAP that decision makers continue to use the sustainability lens of people, planet and prosperity.

The CAP has a very specific environmentally focused goal of reducing greenhouse gas emissions in Baltimore by 15% by 2020, and a majority of the measures have positive social equity benefits. It is important for the Climate Committee, as it examines implementation priorities, strategies, and long-term measures, to clearly and concisely work with partners to identify the economic impacts and benefits of the CAP measures. In addition, the Climate Committee could explore utilizing the Genuine Progress Indicators as an evaluation mechanism. This will ensure that Baltimore remains a green and economically competitive city, and that all three legs of the sustainability stool are balanced.

Many say that the economic cost and impact of inaction far outweigh the cost of implementing greenhouse gas reduction measures. Climate change has the potential to effect economic sectors in Baltimore such as tourism, coastal development, Port operations, and job creation.

Climate strategies have been known around the country to provide opportunities for economic growth and employment development, as well as development opportunities that strengthen local economies. In some cases, the adoption of climate strategies can impose direct and indirect costs on businesses, residents and taxpayers. Given these potential costs and benefits, it should be a priority for the Climate Committee to engage key stakeholders, local champions, trade organizations, and policy analysts who can assist in creating a clear framework for analyzing the economic impacts and benefits of CAP measures as the implementation stages begin.

Some questions for the Climate Committee to consider are:

- Are we evaluating job creation?
- What other comparable cities have similar measures? And what has been the economic impact?
- Will this measure help attract residents and businesses to Baltimore?
- Do the overall benefits of the measure, both economic and environmental, justify the direct and indirect costs of implementing the measure? Are there less costly alternative measures that may have similar benefits?
- Would the Genuine Progress Indicators be an appropriate evaluation tool for the Climate Action Plan?

The Climate Committee will consider these and other integral questions, and will work with partners to develop an economic analysis framework that assists in supporting a sustainable implementation plan that supports all three legs of the sustainability stool – people, planet, and prosperity.

Appendix

Appendix A — Acronyms

ACRONYM	DEFINITION
AHMP	All Hazards Mitigation Plan
ARWG	Adaptation and Response Working Groups
ASHRAE	American Society for Heating Refrigerating, and Air Conditioning Engineers
BCRP	Baltimore City Department of Recreation and Parks
BDC	Baltimore Development Corporation
BEC	Baltimore Energy Challenge
B-CaUSE	Baltimore Colleges and Universities for a Sustainable Environment
BGE	Baltimore Gas and Electric
BOMA	Building Owners and Managers Association
BOS	City of Baltimore Office of Sustainability
BRESCO	Baltimore Refuse Energy Systems Company
BRT	Bus rapid transit
BSW	(City of Baltimore) Bureau of Solid Waste located within the Department of Public Works
BWW	(City of Baltimore) Bureau of Water and Wastewater located within the Department of Public Works
C&D	Construction and demolition
CACP	Clean Air & Climate Protection
CAFE	Corporate Average Fuel Economy
CAP	Climate Action Plan
CH_4	Methane
CHP	Combined heat and power
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalents
DGS	(City of Baltimore) Department of General Services
DOT	(City of Baltimore) Department of Transportation
DPW	Department of Public Works
EPA	United States Environmental Protection Agency
ESS	Energy Savings and Supply
FEMA	United States Federal Emergency Management Agency
GGC	Growing a Green City
GHG	Greenhouse gas
GPS	Global positioning system
GWP	Global warming potential
HCD	(City of Baltimore) Department of Housing and Community Development

ACRONYM	DEFINITION
HERS	Home Energy Rating System
HFC	Hydrofluorocarbons
HVAC	Heating, ventilation, air conditioning
ICC	International Code Council
ICLEI	International Council for Local Environmental Initiatives
IgCC	International Green Construction Code
IPCC	Intergovernmental Panel on Climate Change
IRC	Internal Revenue Code
IRS	Internal Revenue Service
LED	Light-emitting diode
LEED	The Leadership in Energy and Environmental Design developed by the U.S. Green Building Council (USGBC)
LUT	Land Use and Transportation
MARAMA	Mid-Atlantic Regional Air Management Association
MDE	Maryland Department of Environment
MPA	Maryland Port Authority
MRA	Maryland Recycling Act
MTA	Maryland Transit Administration
MWh	Mega-watt hour
N_2O	Nitrous Oxide
NRDC	Natural Resources Defense Council
PFC	Perfluorocarbons
POB	Port of Baltimore
QRSL	Quarantine Road Sanitary Landfill
RPS	Renewable Portfolio Standard
SF_4	Sulfur Hexafluoride
SSIMe	Sustainable Systems Integrated Model - Energy
SWMP	Solid Waste Management Plan
TDM	Transportation Demand Management
VMT	Vehicle miles traveled
WG	Working Group

Appendix B — Acknowledgements

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Appendix C — GHG Inventory Peer Review Memo

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Memorandum

To	Alice Kennedy	Page	1 of 5
cc	Beth Strommen		
Subject	Peer Review of Baltimore City GHG Inventory		
From	George Lu, Claire Bonham-Carter, Brian Goldberg,		
Date	December 12, 2011__REVISED February 16, 2012_Revised March 28, 2012		

One of AECOM's tasks as part of the development of Baltimore's Climate Action Plan (CAP) is to conduct a peer review of the Baltimore City GHG Inventory Review and identify potential revisions which would enable effective CAP implementation and monitoring. The following memorandum describes the peer review findings and updates of the original Baltimore City GHG Inventory Review memorandum submitted on December 12, 2011. The text from the original memorandum has not been changed in order to maintain and carry on the intent of the December 2011 memorandum; however, each action item now includes an update and status. One of the primary findings of AECOM's GHG Inventory Update is the modification of transportation emissions from 33% of the 2010 Baseline Inventory to a revised approximately 15.6% of the inventory by excluding vehicle miles travelled (VMT) which do not originate or terminate in the City and using the Baltimore Metropolitan Council's vehicle miles traveled (VMT) data. . This modification to the transportation sector's proportion of the inventory causes the energy sector's percentage of emissions to increase from 63% to 79%.

In addition to the status of each action item below, notes are provided regarding how each item could be affected or affect the climate action plan (CAP) in the future. Also attached is a summary of the updated baseline year 2010 inventory, which will serve as the existing conditions for the climate action plan.

In addition to the status of each action item, notes are provided for the future of that action item and how it could be affected or affect the CAP in the future. Also attached is a summary of the updated baseline year 2010 inventory, which will serve as the existing conditions for the climate action plan.

The basis of a CAP lies within its first step of a GHG emissions inventory. Through a comprehensive and detailed emissions inventory, a jurisdiction is able to identify where emissions are occurring from and the relative contribution of various operational activities within the jurisdiction. A GHG inventory can guide and focus the development of the CAP to impact those emissions sectors that have the largest reduction potential. In addition, the inventory provides a benchmark from where GHG reductions from CAP measures and actions can be calculated and measured in future updates. Considering this information, the City of Baltimore (the City) decided to conduct a peer review of their 2010 GHG inventory.

AECOM performed a peer review of the 2010 GHG inventory by evaluating the applicability of data sources, emission factors, and quantification methodologies. All emission sectors were evaluated as part of this review.

Appendix C (continued)

AECOM

In general, the 2010 emissions inventory was developed using a bottom-up approach, which uses empirical activity data and results in the most accurate emission calculations. However, a bottom-up approach requires more effort to gather empirical activity data that is used to calculate GHG emissions. The other method is a top-down inventory. A top-down approach uses an inventory from a larger geographical area (e.g., state of Maryland) and proportions the emissions using an indicator (e.g., population). A top-down approach can be inaccurate and misleading because typically a single indicator is not directly proportional to emissions. In addition, future updates to an emissions inventory will not be able to account for the reduction in activity levels and associated emissions. Therefore, the bottom-up approach is preferred because it allows future updates to the inventory to measure the reduction in kilowatt-hours or gallons of water consumed along with their associated emission reductions.

Energy

Overview:
Energy sector data were obtained from the most applicable and accurate source possible (i.e., Baltimore Gas and Electric [BGE] and Maryland Department of Energy's Air and Radiation Management Administration [MDE]). In addition, electricity intensity factors were obtained from Constellation Energy in order to account for the local electricity production portfolio. The energy sector contains the accuracy and specificity required for successful climate action planning. Electricity used by the Port was provided by Baltimore Gas and Electric (BGE) and factored into the Energy sector of the inventory.

Action Items: None.

Transportation

Overview:
Transportation sector data in the form of VMT were obtained from Baltimore Metropolitan Council modeling. VMT data included both fuel and vehicle type, which provides additional specificity for GHG emission rates. However, it should be noted that the transportation sector accounts for VMT occurring within the geographical boundaries of the City regardless of the origin or destination of the vehicle trips. Therefore, a portion of the trips and VMT attributed to the City's inventory could occur from pass-though trips that neither originate nor terminate within the City. The City would not be able to implement measures and actions as part of the CAP to affect those pass-through trips. Furthermore, as discussed in the Greenhouse Gas Emissions Analysis (draft), the origin and destination of trips captured in the inventory are unknown. Therefore, the City's action may only be able to partially affect the decision for each vehicle trip. In other words, land use and/or transportation actions as part of the CAP would affect land uses (e.g., residential, commercial) within the City, but would not be able to affect the origin or destination dynamics from outside of the City. (The Port provided their fuel consumption, which was factored into the Transportation sector.) Assumptions about anticipated jobs forecasts used the following source; Cooperative Forecasts, Baltimore Metropolitan Council, Approved July 27, 2010.

Action Items:

1) Explore the possibility of regional transportation modeling that is land use- and trip-based rather than geographically oriented with the Baltimore Metropolitan Council (BMC). Modeling

Appendix C (continued)

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would provide origin and destination for trips to allow the distinction between internal-internal (I-I), internal-external (I-E), external-internal (E-I), and external-external (E-E) trips. External-external trips would be removed from the GHG inventory, internal-internal trips would be included in their entirety and internal-external or external-internal trips would be halved to allocate only half of the VMT to the City.
2/16/12 Update: AECOM discussed the VMT analysis described above with the Baltimore Metropolitan Council (BMC). BMC was able to provide the VMT data for this analysis for year 2008 and projected year 2035. For the purposes of this analysis, AECOM interpolated the VMT data for year 2010 (and 2020 and 2030 for emission projections). The total VMT data were separated by I-I, I-E, E-I, and E-E VMT. The I-I and E-E VMT included only VMT that occurred within the City boundaries. However, I-E and E-I VMT included the total trip length distance. As discussed above, the total I-I VMT was included in the inventory and all of the E-E VMT was removed from the inventory because the City would not be able to affect those VMT activity through the CAP. However, although the method of removing half of E-I and I-E trip VMT has been adopted as an inventory protocol in some states (e.g., California), it has not yet been adopted regionally in the Baltimore region. Therefore, performing this analysis could leave half of the E-I/I-E trip VMT unaccounted for by any inventory. Hence, total E-I/I-E VMT was included in the inventory, but only the VMT that occurred within the City boundaries. It is assumed that other counties and cities performing inventories will use the standard method of capturing VMT occurring within their geographic boundaries. The planning practice of taking half of total E-I/I-E VMT can be easily performed at a future date when the region is in consensus for this method.

Furthermore, BMC was able to provide a higher level of detail for VMT by vehicle type. BMC's current transportation model can generate VMT data for single occupancy vehicles (SOV), high occupancy vehicles (HOV), medium trucks, and heavy trucks. The percentage of gasoline and diesel vehicles for each of these vehicle types was estimated using the US EPA's State Inventory Tool (SIT) transportation module for the state of Maryland. The earliest year of fuel type data in SIT is 2008, which is likely a reasonable representation of year 2010 vehicle fuel type distribution. Lastly, GHG emissions were quantified using ICLEI's CACP2009 software. Because the model year data for each vehicle type is not available from BMC or SIT, the CACP2009's alternative method for each vehicle type was used to quantify transportation emissions. CACP2009's alternative method provides a default model year distribution for various vehicle types.

The revised inventory now includes VMT emissions that are more closely linked with the land uses in the City and more reasonable to be affected by measures and actions from the climate action plan. The Transportation sector also includes emissions associated with the City's Port fuel usage, public bus fuel usage, and Metro and Light Rail electricity usage, all of which were included in the original inventory and have not been altered as part of this update.

Waste

Overview:
Solid waste sector data was obtained from the Northeast Maryland Waste Disposal Authority (NMWDA), which is the regulatory agency responsible for the solid waste facilities within the City. For

Appendix C (continued)

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solid waste data regarding out-of-City solid waste facilities (i.e., solid waste generated in the City sent to facilities outside of the City), estimations were made using data from the NMWDA. Although NMWDA could provide reasonable estimates of solid waste sent to out-of-City facilities, AECOM recommends weighing the accuracy of these estimates with the labor and time associated with obtaining empirical data from the five out-of-City facilities.

The methodology for solid waste emissions quantification involves the use of the CACP program, which incorporates the US Environmental Protection Agency's WARM model. The WARM model quantifies solid waste emissions on a lifecycle basis (i.e., GHG emissions generated over the complete lifetime decomposition of the waste). Therefore, the solid waste sector includes emissions that occur over the lifetime of waste, rather than an annual estimate, which is how the other emission sectors are measured. This provides some inconsistency among the inventory when some sectors are measured on an annual basis and some on a lifecycle basis.

Action Items:

1) Evaluate the accuracy of out-of-City waste data and weigh that accuracy with the effort involved with obtaining empirical data.
   2/16/12 Update: AECOM contacted NMWDA to inquiry about the method used to provide out-of-City waste data. NMWDA is able to obtain empirical data, which is what was provided for the baseline inventory. Therefore, future updates to the waste sector will easily be able to use the same methods used to perform the baseline and updated inventory.
2) Consider evaluating the City's solid waste disposal on an annual basis rather than lifecycle. Discuss data requirements to model City-generated solid waste emissions.
   2/16/12 Update: Due to the lack of available data from NMWDA and the City, this action item has been omitted from the inventory update. For future inventory purposes, the City can begin to record their own within-City and out-of-City waste disposal.

Water and Wastewater

Overview:
The inventory does not isolate the GHG emissions associated with water conveyance and treatment and wastewater treatment for community water use. AECOM would like to confirm that the electricity and natural gas consumption associated with City Water Delivery Facilities and Wastewater Facilities accounts for the energy needed to provide and move potable water and waste water for the community as well. In addition, the wastewater sector does not include the methane (CH_4) and nitrous oxide (N_2O) emissions associated with wastewater treatment processes, which are part of IPCC's wastewater GHG inventory methodology.

Action Items:

1) Confirm electricity and natural gas associated with City Water Delivery Facilities and Wastewater Facilities are for the community-wide potable water and wastewater systems as well. If not, consider including energy consumption associated with community-wide Water Delivery and Wastewater.
   2/16/12 Update: An inquiry to confirm this information has been sent out by the City. Although no information has been received confirming this question, the City is confident that

Appendix C (continued)

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the information provided in the original inventory is indeed the water and wastewater energy required to serve the City land uses, and not only municipal land uses.

2) Add CH_4 and N_2O emissions associated wastewater treatment processes.

2/16/10 Update: An inquiry for this information was sent out by the City. However, no information or data has been received or compiled at the time of this writing. Therefore, for the purposes of this update, no changes have been made to the wastewater treatment emissions

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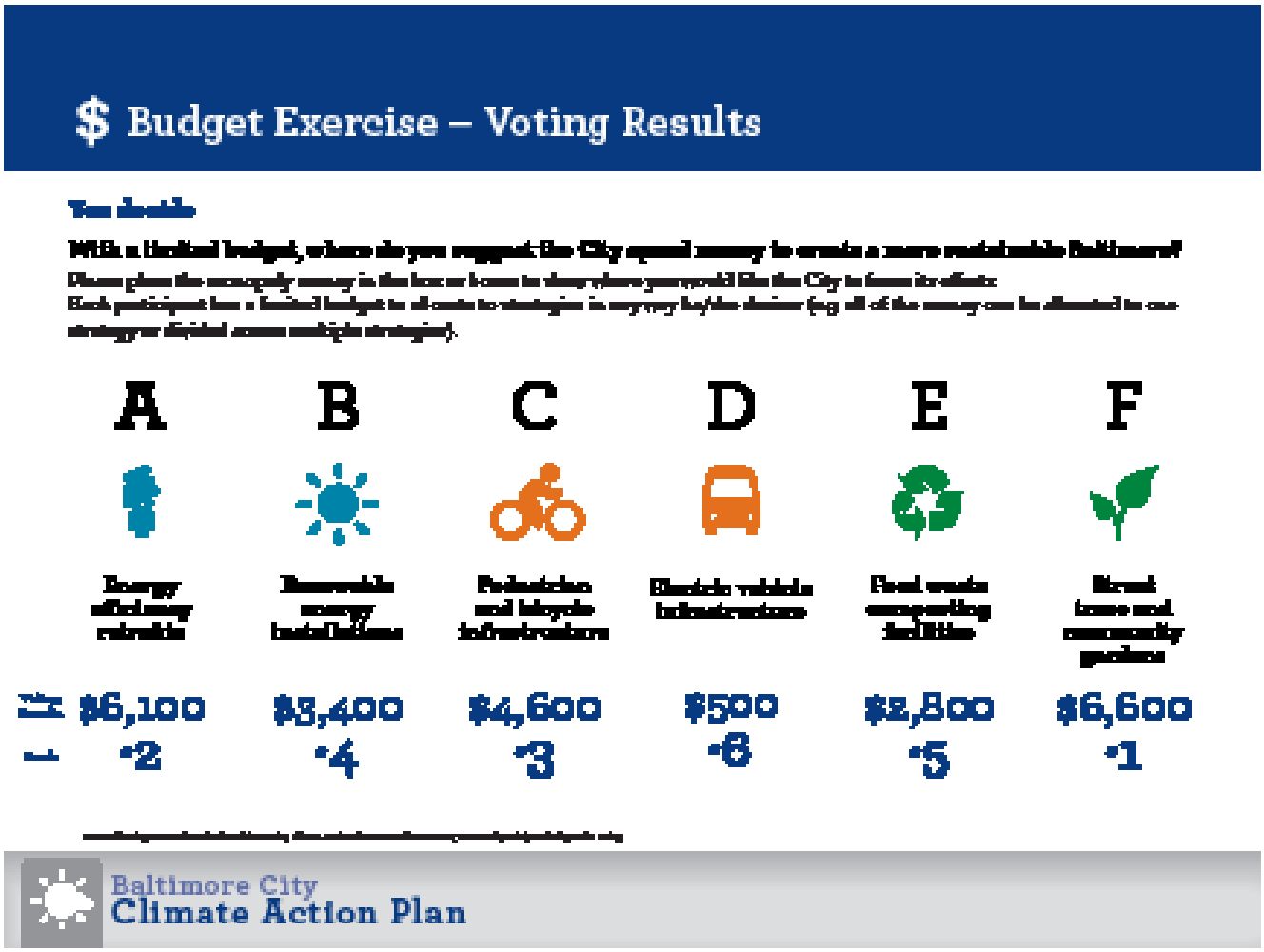
Appendix D — Town Hall Meeting Voting Results

Overall ranked voting results

Rank	Votes	Measure		Reduction Potential
1	78	GGC 3.A	Increase the number of trees planted	Low
2	54	LUT 1.A	Create high-quality pedestrian- and transit-oriented neighborhoods	Low
3	53	ESS 2.C	Lobby state to increase Renewable Portfolio Standard requirement to 33% by 2022	High
4	46	ESS 1.C	Require energy audits and retro-commissioning for City, commercial, industrial, and institutional buildings over 10,000 square feet	Medium
5	42	GGC 1.C	Compost organic material	Low
6	41	LUT 4.C	Expand and improve bicycle infrastructure	Low
7	36	GGC 1.B	Reduce construction and demolition waste	Low
8	34	GGC 1.A	Develop a comprehensive recycling plan	Supporting
9	33	ESS 3.A	Adopt green building standards for new residential construction and major renovation	Medium
10	29	ESS 1.D	Conduct commercial and residential energy efficiency outreach	Medium
11	29	ESS 1.G	Retrofit Baltimore's street lights with more energy-efficient bulbs	Medium
12	28	ESS 1.B	Benchmark and disclose performance of City, commercial, industrial, and institutional buildings	Medium
13	26	ESS 1.A	Disclose residential energy bills at point of sale/rent	Medium
14	23	ESS 2.B	Conduct outreach for solar installations	Medium
15	23	LUT 5.A	Implement a centralized fueling program and route optimization software	Low
16	22	GGC 2.A	Repair water supply infrastructure	Low
17	21	LUT 2.A	Develop, implement, and promote individualized transportation demand management programs	Medium
18	19	ESS 3.B	Modify existing new homeowner and rehabilitation tax credit to include energy efficiency standards based on the Home Energy Rating System (HERS)	Low
19	19	ESS 4.A	Encourage new facilities to consider connecting to existing, proximate, co-generation facilities	Supporting
20	17	ESS 2.A	Standardize permitting for renewable energy installations	Supporting
21	17	LUT 1.B	Support existing mixed-use neighborhoods that increase access to goods and services	Low
22	17	LUT 5.B	Promote fuel-efficient trucking in the Port of Baltimore	TBD
23	16	LUT 4.A	Develop a pedestrian master plan	Low
24	16	LUT 5.A	Support alternative fuel infrastructure and encourage adoption of alternative-fuel vehicles	TBD
25	13	LUT 2.B	Promote establishment of qualified bike commute reimbursement programs	Supporting
26	12	ESS 1.F	Expand outreach program in schools for existing residential	Supporting
27	12	ESS 1.H	Promote cool roof installations	Low
28	11	GGC 2.B	Improve water efficiency in existing small residential buildings	Low
29	9	LUT 3.A	Explore the implementation of a parking plan for city-owned parking that prioritizes short-term parking downtown and limits commuter parking	TBD
30	7	ESS 4.B	Encourage co-generation installation for replacing inefficient boilers	Supporting
31	7	GGC 2.C	Improve water efficiency for new construction and major renovations of small residential buildings	Low
32	5	LUT 4.B	Support Safe Routes to Schools	Supporting
33	2	ESS 1.E	Encourage model green lease provisions	Supporting
34	2	LUT 3.C	Reduce off-street parking	Supporting
35	0	LUT 3.B	Provide alternatives to monthly parking passes	Supporting

Note: Voting was conducted at the Baltimore Climate Action Plan Town Hall on June 26, 2012. Each participant had 12 votes.

Appendix D (continued)



NOTE: Voting was conducted at the Baltimore City Climate Action Plan Town Hall on June 26, 2012. Each participant had $400 for voting.

Appendix E — SSIMe Level I Assumptions for Baltimore

Residential Methodology

1. Filtered Residential Energy Consumption Survey (RECS) down to Census Region South Atlantic, Urban, Climate Zone 3, Year constructed before 1950, and appropriate housing type to check the heating fuel type, heating equipment age, water heater fuel type, average water heater equipment age, cooling type, and cooling equipment age for each housing type.
2. Baseline data comes from the energy end use consumption of South Atlantic census region, Climate Zone 3, year constructed before 1950, and appropriate housing type (except Apt 5+ which is just by zone 3 and housing type because dataset was too small).
3. Assumed heating cooling, and water heating efficiencies are based years collected from step 1. (See chart below gathered from RECS in step 1.)

TYPICAL 2009 DATA

Residential	Single-Family Detached	Single-Family Attached	2-4 Apts	5+ Apts
Size (square feet)	1,500	1,300	1,000	800
Year Constructed	Before 1950	Before 1950	Before 1950	Before 1950
Heating Fuel	Fuel Oil, Natural Gas	Natural Gas	50/50 natural gas, electricity	Mostly natural gas
Heating Age	Mostly 10-14 or 20+ years	Mostly 20+ years	5 years old	13 years old
Water Heater Fuel	Electricity	Natural Gas	Natural Gas	50/50 natural gas, electricity
Water Heater Average Age	5 years old	Pretty spread apart, assume 10 years old	5 years old	5 years old
Cooling Type	60% wall units; 40% central	50/50 window and central	50/50 window and central	Window wall units
Cooling Device Age	Mostly 5-9 years old	Assume 10 years old for Central, 5 years old for window wall units	average 5 for central, 3 years old window	average 5 years for window wall units

Items to Note for Residential

- Heating and cooling reduction factors for attic insulation and window replacement comes from simulated IES model.
- Cost for attic insulation and window replacement comes from NREL Energy efficiency Database, http://www.nrel.gov/ap/retrofits/measures.cfm?gId=1&ctId=2&scId=6.
- For lighting, the energy savings is estimated to be 37.5% switching from incandescent to CFLs. 60W incandescent is replaced with a 15W CFL. This is a 75% savings. It was assumed that houses are already 50% CFL and 50% incandescent, so therefore the energy savings is 75% * 50% = 37.5%.
- Assumed 25 light bulbs that need replacing at for SFD and SFA. Only 20 light bulbs in apartments.
- Across larger datasets the Apt 2-4 Units have higher energy intensities than SFD. Most likely due to similar equipment and people gains, however, smaller square footage. It's more concentrated driving the end use intensity higher.
- Across larger datasets the Apt 5+ Units have lower cooling energy intensities than Apt 2-4, but higher than SFA, due to less external wall area (increased shared walls between other apts with similar conditions).

Non-residential Methodology

1. Filtered Commercial Building Energy Consumption Survey (CBECS) down to Census Region South Atlantic, Urban, Climate Zone 3 and appropriate principal building activity to check the average size of building, year constructed, and heating equipment type for each building type.
2. Baseline data comes from the website: http://buildingsdatabook.eren.doe.gov/CBECS.aspx filtering to building type, census region, and climate zone.
3. Assumed all building types were natural gas for heating, water heating, and cooking.

Appendix E (continued)

4. Assumed heating, cooling, and water heating efficiencies and lighting power density, on average, to be 10 years old. Therefore applying efficiencies from 10 years ago as baseline efficiencies to baseline energy end usages. See assumed average CBECS HVAC Age below:

TYPICAL 2003 DATA

COMMERCIAL BUILDING TYPE	SIZE (SQUARE FEET)	YEAR CONSTRUCTED	ASSUMED CBECS HVAC AGE	HEATING EQUIPMENT
Office	234,706	1975	1995	packaged heating units
Warehouses	48,815	1985	1995	packaged heating units
Food Sales	17,480	1965	2002	furnaces that heat directly
Inpatient	460,000	1965	2002	boilers
Food Service	8,895	1975	1995	furnaces
Retail	61,574	1985	1995	furnaces
Education	94,508	1965	1995	boilers

Items to Note for Nonresidential

- Improving envelope could mean applying weatherization measures.
- Cost for this comes from the Database for Energy Efficiency Resources (DEER), upgrading old attic insulation to current attic insulation standards.
- Assumed ventilation is 100 cubic feet per minute (CFM) per 1 horsepower (hp) to determine rebate for ventilation. However, it was more than the assumed cost and therefore it was equivalent to the cost of the variable frequency drive (VFD) retrofit.
- There is a breakdown for lighting, however, no breakdown for exterior versus interior. It was assumed that 20% of the lighting breakdown is exterior.
- Education is a mix of colleges/universities, schools, and daycares.

Energy Conservations Measures (ECMs) to NOT consider

RESIDENTIAL	NON-RESIDENTIAL
No solar thermal	No lighting
No appliances	No solar thermal
No PV	No PV

Appendix F — Federal & State Adaptation Activities

Further Federal Agency Activities

- National Action Plan for Freshwater Resources (Council on Environmental Quality- CEQ)
- National Fish, Wildlife and Plants Climate Adaptation Strategy (CEQ)
- Animal and Plant Health Inspection Service (United States Department of Agriculture- USDA)
- Global Climate Change Mitigation Incentive Fund (Economic Development Administration- EDA)
- NIST-NOAA Resilient Communities (National Institute of Standards and Technology- National Oceanic and Atmospheric Association)
- Sentinel Sites (NOAA)
- Memorandum of Understanding between USACE (United States Army Corps of Engineers), USGS (United States Geological Survey) and NOAA to support Collaborative Science, Services and Tools to Support Integrated and Adaptive Water Resources Management (May 2011)
- Building Technologies and ENERGY STAR (Department of Energy)
- Climate-Ready States and Cities Initiative (Centers for Disease Control and Prevention)
- National Environmental Public Health Tracking Network (Centers for Disease Control and Prevention)
- Strategic Foresight Initiative (FEMA)
- Risk MAP (Mapping, Assessment and Planning) Multi Year Plan (March 2009) spans FY10-FY 14 (FEMA)
- Coastal Construction Manual (2008) (FEMA)
- Consolidated Planning Enhancement Initiative (Housing and Urban Development- HUD)
- Long-Term Disaster Recovery Working Group (Homeland Security and HUD)
- Foundation of Healthy Communities and a Healthy Environment (joint project of EPA, USACE, USDA and DOI (Department of the Interior))
- Atlantic Coast Study – the Potential Impacts of Global Sea Level Rise on Transportation Infrastructure (2008) (DOT)
- Integrating Climate Change into the Transportation Planning Process (June 2008) (DOT)
- Climate Change Adaptation Peer Exchanges (DOT)
- National Water Program (NWP) Strategy: Response to Climate Change (EPA)
- Climate Ready Estuaries Program (EPA)
- Climate Ready Water Utilities (EPA)
- Basins 4.0 Climate Assessment Tool (EPA)

Further Maryland Activities

The Maryland Department of Natural Resources (DNR) leads the state's efforts to adapt to climate change and coordinates across state agencies. The Maryland Department of Natural Resources created a policy: Building Resilience to Climate Change, issued in October 2010, to guide their investments in and management of land, resources and assets so as to better understand, mitigate and adapt to climate change. The policy establishes practices and procedures related to new land investments, facility siting and design, habitat restoration, government operations, research and monitoring, and resource planning and advocacy. Through implementation of the policy, the agency is leading by example and encouraging others to plan for and to mitigate the effects of climate change. DNR has developed the Coastal Atlas (shorelines.dnr.state.md.us/), which allows state and local governments and organizations to visualize the impacts of sea level rise and storm surge on flooding, shoreline erosion and loss of habitat. This tool, along with others is being used to guide land conservation efforts and to assist local governments in planning for the impacts of climate change across the state. DNR is also currently working to maintain and improve the longevity of trees in urban areas and increase the urban canopy cover throughout Maryland.

Appendix F (continued)

The Maryland Department of Transportation is working to assess Maryland's critical transportation facilities and systems' vulnerability to protracted sea level rise and extreme weather damage. This assessment will provide the information necessary to evaluate options for dealing with potential impacts to infrastructure and connectivity and aid in the development of adaptation policies for existing and planned transportation facilities. The assessment will ultimately influence long-term strategic planning for system adaptation that can account for the uncertainty of future climactic conditions.

The Department of Health and Mental Hygiene (DHMH) is working with other state agencies to review all climate change and energy related policies and legislation for the health benefits and risks to all Maryland residents. DHMH is working with the Commission on Environmental Justice and Sustainable Communities, the Maryland Department of Environment (MDE) and the Maryland Department of Planning (MDP) on the introduction of health indicators that could be used by MDP and other agencies to evaluate the potential impacts of climate change adaption or mitigation strategies and the potential health consequences for projects related to adaption of sea level rise. In 2002, DHMH received funding from the CDC to plan a statewide Environmental Public Health Tracking Network. Maryland used the funding to build capacity and enhance infrastructure. The results range from starting or improving surveillance, to enabling faster responses to environmental public health questions and faster action to prevent diseases. Maryland State officials also track the spread of West Nile Virus and other arboviral activity in the state in vector species, host animals and humans.

Other State Activities

- Lead By Example: Building Resilience to Climate Change (DNR)
- Review of Current State-wide Building Codes and Recommendations for Enhancement in Coastal Regions of Maryland (HCD)
- Promote the assessment of health impacts when evaluating state policies on Greenhouse Gas Reductions (DHMH)
- Enhanced Environmental Public Health Tracking infrastructure (DHMH)
- Development of Climate Health Indications. (DHMH/MDE/MDP)
- Vector-borne disease surveillance and control (DNR)
- Urban Tree Canopy Assessment (DNR)
- Tools for Water utilities (MDE)
- Developing source water protection implementation plans measures for vulnerable communities
- Climate Change Criteria For Conservation (DNR)
- Chesapeake Bay National Estuarine Research Reserve's Coa1stal Training Program (DNR)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