

Pathways to the Future

AIR QUALITY



Comprehensive
Climate Action Plan for
the Richmond region
2025

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Acronyms and Abbreviations

AC	Air conditioning
ACEEE	American Council for an Energy-Efficient Economy
AEO	Annual Energy Outlook
AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation
AFV	Alternative fueled vehicle
AI	Artificial intelligence
ARMS	Agricultural Resource Management Survey
ASE	Automotive Service Excellence
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ATJ	Alcohol to jet
BAEE	Best Available Energy Efficiency
BAU	Business-as-usual
BEV	Battery electric vehicle
BIPOC	Black, Indigenous, and People of Color
BLS	Bureau of Labor Statistics
BOD	Biological oxygen demand
BRT	Bus Rapid Transit
BTS	Bureau of Transportation Statistics
C&D	Construction and demolition
CAC	Climate action committee
CAP	Criteria air pollutants
CARB	California Air Resources Board
CAST	Chesapeake Assessment Scenario Tool
CBF	Chesapeake Bay Foundation
CBO	Community-based organizations
CBPA	Chesapeake Bay Preservation Act
CDL	Commercial Driver's License
CEA	Certified Energy Auditor

CEDS	Comprehensive Economic Development Strategy
CHP	Combined heat and power
CMAQ	Congestion mitigation and air quality
CO	Carbon monoxide
COBRA	Co-Benefits Risk Assessment
CPRG	Climate Pollution Reduction Grant
CVWMA	Central Virginia Waste Management Authority
CWSRF	Clean Water State Revolving Funds
DCIM	Data Center Infrastructure Management
DCR	Department of Conservation and Recreation
DEQ	Department of Environmental Quality
DER	Distributed Energy Resources
DERA	Diesel Emissions Reduction Act
DHCD	Department of Housing and Community Development
DOE	Department of Energy
DOF	Department of Forestry
DWR	Department of Wildlife Resources
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EPD	Environmental Product Declarations
EQIP	Environmental Quality Incentives Program
ERS	Economic Research Service
ESPC	Energy saving performance contracting
EUI	Energy use intensity
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
EWG	Equity Working Group
FAA	Federal Aviation Administration
FAF	Freight Analysis Framework
FBAR	Field Burning of Agricultural Residues

FCEV	Fuel cell electric vehicle
FDA	Food and Drug Administration
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FLIGHT	Facility-Level Information on Greenhouse gases Tool
FT	Fischer Tropsch
FTA	Federal Transit Administration
GHG	Greenhouse gas
GHGRP	Greenhouse Gas Reporting Program
REET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
GRIP	Grid Resilience and Innovation Partnerships
GRTC	Greater Richmond Transit Company
GWP	Global warming potential
HAP	Hazardous air pollutants
HEAR	Home Energy Rebate
HEFA	Hydroprocessed Esters and Fatty Acids
HEP	Home Energy Professional
HPE	Hewlett Packard Enterprise
HR	Hampton Roads
HUD	Housing and Urban Development
HVAC	Heating, ventilation, and air conditioning
ICEV	Internal combustion engine vehicle
IECC	International Energy Conservation Code
IP	Industrial process
IPCC	Intergovernmental Panel on Climate Change
IPEDS	Integrated Postsecondary Education Data System
IRA	Inflation Reduction Act
IRS	Internal Revenue Service
IT	Information technology
LBNL	Lawrence Berkeley National Lab

LCFS	Low carbon fuel standard
LD	Light duty
LDV	Light-duty vehicle
LEED	Leadership in Energy and Environmental Design
LIC	Landscape Industry Certified
LMI	Low-to-moderate income
LMOP	Landfill Methane Outreach Program
LQ	Location quotient
LTO	Landings and takeoffs
MACC	Marginal Abatement Cost Curve
MAP	Mini-Action Plans
MECS	Manufacturing Energy Consumption Survey
MHDV	Medium and heavy-duty vehicles
MOVES	Motor Vehicle Emissions Simulator
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
MSW	Municipal solid waste
MT	Metric ton
MTBS	Monitoring Trends in Burn Severity
MW	Megawatt
NAPEE	National Action Plan for Energy Efficiency
NASS	National Agricultural Statistical Service
NATE	North American Technician Excellence
NCCER	National Center for Construction Education & Research
NCES	National Center for Education Statistics
NEI	National Emissions Inventory
NGO	Non-governmental organizations
NI	Nitrification Inhibitor
NLCD	National Land Cover Dataset
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory

NUE	Nitrogen use efficiency
NWL	Natural and working lands
O&M	Operating and maintenance
ODS	Ozone depleting substances
PACE	Property Assessed Clean Energy
PCAP	Priority Climate Action Plan
PE	Professional Engineer
PHEV	Plug-in hybrid electric vehicle
PJM	Pennsylvania-New Jersey-Maryland Interconnection
PMRP	Priority Methane Reduction Projects
PNNL	Pacific Northwest National Laboratory
PPA	Power Purchasing Agreements
PPA	Power purchase agreements
PUE	Power use effectiveness
PV	Photovoltaic
PVIP	PV Installation Professional
PVIS	PV Installer Specialist
PVTS	PV Technical Sales
RD	Renewable diesel
REAP	Rural Energy for America Program
RMT	Richmond Marine Terminal
RNG	Renewable Natural Gas
RNRF	Renewable Natural Resources Foundation
ROI	Return on investment
RRTPO	Richmond Regional Transportation Planning Organization
RSES	Refrigeration Service Engineers Society
SAF	Sustainable aviation fuel
SCC	State Corporation Commission
SEDS	State Energy Data System
SERT	Server Efficiency Rating Tool
SIT	State Inventory Tool

SLOPE	State and Local Planning for Energy
SOC	Standard occupational classification
SPEC	Standard Performance Evaluation Corporation
SRVC	SERC Virginia/Carolina region (SRVC)
STBG	Surface Transportation Block Grant
SWCD	Soil and Water Conservation Districts
TPO	Transportation Planning Organization
TRIMMS	Trip Reduction Impacts of Mobility Management Strategies
TRIV	Transforming Rail in Virginia
TWIC	Transportation Worker Identification Credential
UPS	Uninterruptible power supplies
USDA	United States Department of Agriculture
USFS	United States Forest Service
VaNLA	Virginia Natural Landscape Assessment
VCEA	Virginia Clean Economy Act
VDEQ	Virginia Department of Environmental Quality
VDOT	Virginia Department of Transportation
VMT	Vehicle miles traveled
VOC	Volatile organic compounds
VPA	Virginia Port Authority
VPPSA	Virginia Peninsulas Public Service Authority
WARM	Waste Reduction Model
WCAP	Wildlife Corridor Action Plan
WMP	Waste management plan
WUE	Water Usage Effectiveness
WWTP	Waste water treatment plant
ZEV	Zero-emission vehicle

Definitions

Greenhouse Gas (GHG)	The air pollutants carbon dioxide (CO ₂), hydrofluorocarbons (HFCs), methane (CH ₄), nitrous oxide (N ₂ O), perfluorocarbons (PFCs), and sulfur hexafluoride (SF ₆). While some GHGs are naturally occurring, they are considered pollutants when in excessive quantity and when they come from anthropogenic (human-caused) sources.
GHG Inventory	A list of emission sources and sinks and the associated emissions quantified using standard methods.
GHG Reduction Measure	Policies, programs, actions, or projects that reduce GHG emissions or enhance carbon removal. Measures that enhance carbon removal are those that increase the uptake of carbon dioxide from the atmosphere (see Sequestration).
Co-Benefits	Positive effects beyond the stated goal of a GHG reduction measure (e.g., improved public health outcomes, economic benefits, increased climate resilience).
Carbon Dioxide Equivalent (CO₂e)	A common unit that expresses the warming impact of any greenhouse gas in terms of how much carbon dioxide (CO ₂) would cause the same amount of warming over 100 years.
Carbon Sink	A natural or artificial reservoir that removes and stores carbon dioxide, preventing it from entering the atmosphere as a pollutant. Examples of carbon sinks included soils, oceans, and woody vegetation.
Community-Scale Aggregation Program	By aggregating demand, these programs can offer participants lower prices, vetted installers, simplified procurement, and technical support, making it easier and more affordable for residents to adopt clean energy.
Distributed Energy Resources	Decentralized sources of electricity production, typically from many small producers instead of large, utility-scale power plants. Ex: solar panels on households
Embodied Carbon	Emissions from the entire lifecycle of a product, from raw material extraction to manufacturing, transportation, maintenance, and disposal.
Green Infrastructure	Green infrastructure uses vegetation, soils, and other natural elements to provide critical services for communities such as flood protection, improved air and water quality, and protection against heat. Green infrastructure also provides social benefits such as access to green space.
Metric Ton (MT)	1 metric ton = 1,000 kilograms. That is about 2,205 pounds or 1.1. US tons (also known as short tons).
Micro-Transit	Flexible, on-demand transportation service that uses smaller vehicles to provide shared rides along dynamic routes.
Renewable Natural Gas (RNG)	Biogas (methane) captured and refined for use in place of fossil natural gas. Sources of biogas may include landfills, water treatment plants, anaerobic digesters, etc.
Sequestration	The process by which carbon dioxide is pulled out of the atmosphere and stored (see Carbon Sink). An example of natural sequestration is the uptake of carbon by vegetation and subsequent storage in soils and plant tissues.

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Authors

Nicole Keller, Resilience Planner
Support provided from contracting partner, ICF

Contributors

Sarah Stewart, REME Director	Ellen Cook, Project Manager
Eli Podyma, Environment Planner	Barbara Jacocks, Dir. of Community Development
Sarin Adhikari, Principal Data Manager	Holly Gordon, Sr. Community Engagement Manager
Eizabeth Greenwell, Data Analyst	Kristin Hott, Community Engagement Coordinator

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Jay Ellington, Crater PDC	Clay Bowles, Chesterfield County	Samantha Hudson, Henrico County
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Introduction



Introduction

The *Pathways to the Future: Air Quality* Plan is the first regional approach to climate action planning in central Virginia. This plan reflects two years of collaboration between localities in the Richmond metropolitan statistical area (MSA), with significant input from private stakeholders, nonprofit and community-based organizations, and the public. It charts a path towards a clean energy economy for the MSA's 18 localities and 5 Indigenous nations - envisioning a future with better air quality, better health outcomes, and a strong and diverse economy. This vision will be co-created; each community can identify the pieces of the puzzle they will contribute, and we will work together towards the shared goals set forth in this plan.

The Air Quality Plan complements – rather than replaces – other local, regional, and state planning efforts. It is intended to sit alongside comprehensive plans, transportation plans, equity and sustainability strategies, and economic development initiatives, aligning across multiple policy areas without superseding or duplicating them. Parallel plans are being developed by Hampton Roads PDC, Metro-Washington Council of Governments, and Virginia Department of Environmental Quality (VDEQ), all supported through the same federal grant program. Once completed, every locality in the state will be covered by a plan.

Through the lens of PlanRVA's regional planning portfolio, the Air Quality Plan is part of a set of core regional plans which make up the [2025-2030 Regional Strategic Plan: Pathways to the Future](#)¹. The Regional Strategic Plan includes the Long-Range Transportation Plan, the Richmond-Crater Multi-Regional Hazard Mitigation Plan, the Comprehensive Economic Development Strategy (CEDS), and the Natural Resources Plan. Together, these plans advance PlanRVA's Strategic Vision: Strategic and Resilient Infrastructure, a Healthy Environment, Attainable Housing, a Strong Economy, and Opportunity and Choice for Everyone.

A large portion of the Crater Planning District is also covered by the regional Air Quality Plan, and their participation was essential to ensuring that the plan reflects priorities across jurisdictional boundaries. Crater's input helps situate this plan within their own body of work, including Plan2045, the Long-Range Transportation Plan; the forthcoming Crater Regional Resilience Plan; and the [2023–2028 Crater Region CEDS](#), which emphasizes connectivity, quality of life, and sustainable economic growth.

The Pathways to the Future: Air Quality Plan has been a data-driven, collaborative process, and an opportunity to consider aspirations for the future. The following pages offer a framework for localities in the Richmond MSA to work collaboratively to address climate change and air pollution.



Sheep on the Skipjack Solar Farm in Charles City County. Source: James River Grazing

¹ <https://planrva.org/home/about-the-commission/regional-strategic-plan/>

Purpose and Scope

Authorized by Congress under the Inflation Reduction Act (2022), the Climate Pollution Reduction Grant provided first-of-its-kind funding for states, local governments, Indigenous nations and territories to develop plans for reducing greenhouse gas emissions and other harmful air pollution. Virginia was awarded four of these grants: one for the state itself, led by the Department of Environmental Quality (DEQ), and the three largest MSAs: Metro Washington, Hampton Roads, and Richmond. While each of the four plans was developed independently, they represent parallel efforts carried out under the same federal program and developed in coordination. PlanRVA provided leadership to ensure that the project reflects the regional priorities of the Richmond MSA and is aligned with the principle of community self-determination. By setting a shared regional vision and defining evidence-based, actionable steps, we can make the most of available funds and build momentum for lasting success.

Figure 1: Richmond Metropolitan Statistical Area (MSA)



The goal of the **Pathways to the Future: Air Quality Plan** is to guide localities, Indigenous nations, agencies, industry, and communities to work together to reduce emissions, improve local air quality, grow our clean energy workforce, and ensure a just and equitable energy transition, especially in overburdened communities². This plan reflects significant input from the community.

This plan covers the full Richmond MSA, covering 13 counties and 5 independent cities and towns. It also belongs to the 5 sovereign Indigenous nations of the region: The Chickahominy Indian Tribe, the Chickahominy Indian Tribe-Eastern Division, the Pamunkey Indian Tribe, the Rappahannock Indian Tribe, and the Upper Mattaponi Indian Tribe.

The plan includes data on greenhouse gases (GHG) and other air quality pollutants in the region; identifies key strategies, or measures, to reduce emissions in the region; provides a potential pathway to net zero GHG emissions by 2050; and includes an assessment of potential co-benefits and workforce considerations for implementing the identified measures.

The plan includes a total of 22 measures across six sectors:

- **Buildings:** The buildings sector includes commercial, industrial and residential buildings. Buildings can run more efficiently and be more resilient to the impacts of climate change, helping to keep the lights on while consuming less power.

² Communities that face higher levels of environmental pollution and related health risks, often compounded by social and economic conditions that limit their ability to respond.

- **Energy Supply:** Cleaner sources of energy can be used to power our homes, businesses, and transportation.
- **Industry:** The industrial sector includes activities such as the processing and manufacturing of physical and chemical materials and is a difficult sector to decarbonize. Finding collaborative solutions for clean energy use and efficiency can help reduce pollution.
- **Natural and Working Lands (NWL):** Conserving, restoring, and managing lands to enhance their benefits – such as forest preservation and increased tree canopy – can support GHG reductions and enhance community resilience. There is also discussion on managing lands used for agricultural activities, including growing crops and livestock grazing, to reduce emissions.
- **Transportation:** This sector includes on-road and off-road (including airports, ports, etc.) transportation. Activities such as switching to electric and fuel-efficient vehicles and equipment, increased use of public transportation, and options like walking and biking can have major community and health benefits.
- **Solid Waste and Wastewater:** This sector focuses on emission reductions in solid waste and wastewater management. Better recycling practices and expanded composting activities can help reduce emissions from our landfills, and process efficiency improvements can help reduce emissions from wastewater treatment plants.

Approach to Plan Development

The *Pathways to the Future: Air Quality Plan* was developed over a two-year period through a collaborative process involving PlanRVA, local governments, stakeholder organizations, and residents across Central Virginia. PlanRVA was awarded the Climate Pollution Reduction Grant (CPRG) from the US EPA in August and 2023. We procured ICF to provide technical support for the Priority Climate Action Plan (PCAP) and the Comprehensive Climate Action Plan (CCAP) and engaged The Hodges Partnership and Floricane to support communications and public engagement for the PCAP.

Formal plan development began in December 2023 with the first convening of the project Steering Committee. Membership to the Steering Committee was open to representatives from all 18 localities and five Indigenous Tribes within the Richmond MSA, as well as the region's other planning district commissions (PDCs). Although participation varied over time, a core group of members met 12 times between December 2023 and December 2025. Acting as liaisons to local staff and elected bodies, Committee members ensure the plans reflected the priorities and needs of their respective communities. Members proposed reduction measures and key actions, suggested potential performance metrics, connected residents to engagement opportunities, and reviewed successive drafts of the Air Quality Plan. They also unanimously endorsed the region's 2035 and 2050 GHG reduction targets and agreed to establish a goal of adding 2 GW of solar generation by 2050.

With guidance from the Steering Committee and substantial public input (see the Engagement Activity Summary below), PlanRVA published the PCAP in March 2024, identifying Transportation and Waste as the region's priority sectors. During the summer of 2024, we established six sector-specific workgroups to inform development of the Air Quality Plan. These workgroups – composed of community organizations, advocacy groups, major employers, state agencies, and professional associations – provided critical insight into sectoral challenges, offered recommendations for GHG reduction measures, and helped ensure the plan incorporated private sector and advocate voices.

Throughout 2025, PlanRVA and ICF continued to engage the Steering Committee in the technical components of plan development, including review of the 2022 regional GHG inventory, modeling of

Business-as-Usual and Net-Zero Pathway scenarios, and refinement of proposed measures. In summer 2025, PlanRVA conducted a regional workforce consultation through a webinar and survey, soliciting input from workgroup participants, employers, training providers, and economic development entities. This feedback contextualized labor-market data and helped clarify workforce needs associated with full implementation of the Air Quality Plan.

Local governments reviewed multiple iterations of the final plan in fall 2025. Following this review process, PlanRVA published the *Pathways to the Future: Air Quality Plan* on December 1, 2025.

Engagement Activity Summary

PlanRVA was heavily committed to conducting meaningful public engagement to help inform the Air Quality Plan. We conducted two major outreach campaigns, provided engagement opportunities in English, Spanish, and multiple other languages, and utilized multiple engagement platforms. The first round of engagement relied on SurveyMonkey and in-person conversations, including over the phone, through focus group discussions, and sidewalk interviews. The second round of engagement utilized the SocialPinpoint.

PlanRVA’s efforts were recognized as an example of outstanding participatory climate planning by the Southern Economic Advancement Project and the National Conference on Citizenship³. After the first round of engagement, PlanRVA published a separate [Community Report](#) that summarized feedback from residents⁴.

Public engagement throughout the process revealed a community deeply invested in building a healthier, more resilient, and more equitable region. Residents consistently voiced a desire for bold, structural action on climate change – approaches that go beyond individual responsibility and reflect shared accountability among governments, institutions, and industry. Participants emphasized that climate planning should prioritize people: their mobility, their homes, their health, and their access to clean air and green spaces.

Transportation was one of the most frequently discussed issues, with community members urging a firm shift away from car-dependent infrastructure. Residents called for safer, more extensive networks of sidewalks, bike lanes, and transit routes that make it easier to move around without relying on personal vehicles.

In the energy sector, enthusiasm for solar power was widespread. Residents supported expanding rooftop systems and maximizing opportunities on public buildings, brownfields, and other underutilized spaces. However, concerns about the rapid growth of data centers surfaced repeatedly. Community members saw these facilities as energy-intensive land uses that threaten to offset local clean-energy gains. People also emphasized the importance of reducing barriers and costs associated with solar access, ensuring that clean energy benefits are available to all communities.



³ <https://theseap.org/regional-climate-action-planning-achievements-in-american-south/>

⁴ <https://www.rva-airquality.org/documents>

Feedback on buildings focused on energy efficiency, tenant protections, and fair access to upgrades. Residents supported shifting toward more sustainable construction, streamlined permitting for sustainable design, and incentives that encourage energy-efficient retrofits. However, community members cautioned that sustainability investments must not come at the expense of housing affordability. Many were concerned that upgrades to older housing could lead to increased rents or displacement without proper safeguards.

Industry-related feedback highlighted a desire for clearer emissions strategies and stronger climate accountability. Participants supported sustainable procurement practices but felt the region should be more direct about expectations for large energy users and industrial facilities. Generally, there was a desire to see more impactful and transparent systems to hold industry accountable for externalities. Data center concerns were pronounced in this sector, with residents urging local governments to balance economic development goals with environmental and community impacts.

Waste reduction and circular economy issues received broad community support. Residents advocated for expanding recycling and composting access, reducing reliance on fee-based systems, and ensuring waste programs are easy to use and widely available. Litter issues were a top-cited environmental concern. Composting, in particular, generated enthusiasm—especially if paired with local processing that could produce usable compost for gardens, farms, and community green spaces.

Among the Natural and Working Lands topics, residents expressed a clear desire for stronger conservation measures. Participants underscored the importance of protecting farmland, forests, and watersheds, urging greater coordination with conservation organizations and local partners. Residents also highlighted opportunities for broad public education campaigns on native plants, pollinators, regenerative agriculture, and invasive species management.

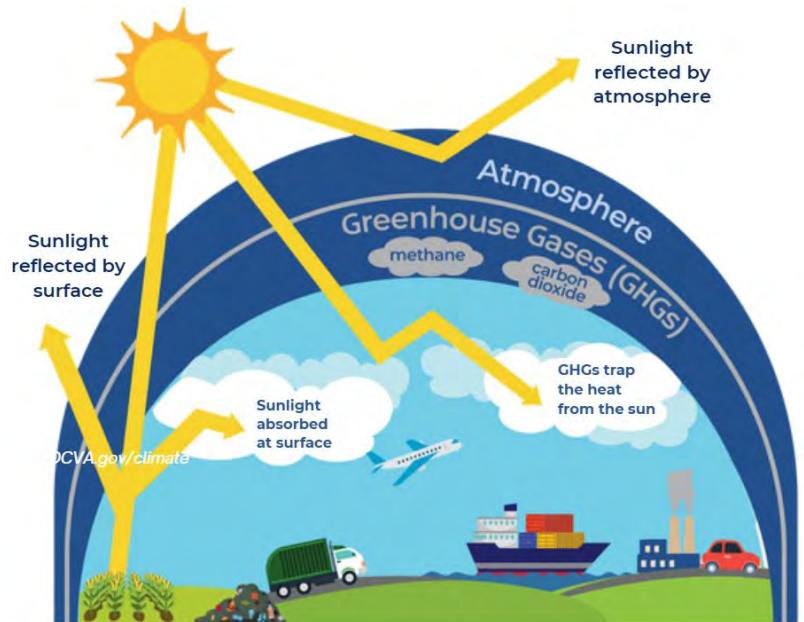
Taken together, public feedback reflects a region ready for transformative climate action. Residents want coordinated investments in clean energy, walkable communities, healthy ecosystems, and equitable access to the benefits of a sustainable future. They urged decision-makers to address structural barriers, prioritize accountability, and ensure that climate strategies uplift the communities they are designed to serve.

How To Read This Report: Key Terms

What Are Greenhouse Gases?

Gases are released through industrial and natural processes and when burning fossil fuels, such as from driving cars, heating buildings, producing electricity, and farming. These gases trap heat in the atmosphere, causing climate change and an increase in the average global temperature. There are six main GHGs:

1. **Carbon dioxide (CO₂)** – from burning fossil fuels like coal, oil, and gas
2. **Methane (CH₄)** – from landfills, livestock, and natural gas systems
3. **Nitrous oxide (N₂O)** – from fertilizers, farming, and some industrial processes
4. **Hydrofluorocarbons (HFCs)** – used in refrigeration and air conditioning
5. **Perfluorocarbons (PFCs)** – from aluminum production and electronics manufacturing
6. **Sulfur hexafluoride (SF₆)** – used as an insulating gas in electrical equipment



What does “CO₂ Equivalent” Mean?

Not all greenhouse gases are equal — some trap much more heat than others. To make it easier to compare and add up the impact of different gases, scientists use a unit of measurement called *carbon dioxide equivalent*, or **CO₂e**. CO₂e is a common unit that expresses the warming impact of a greenhouse gas in terms of how much carbon dioxide (CO₂) would cause the same amount of warming over 100 years. This standard way of measuring helps us understand the total impact of all emissions, using one consistent unit — no matter which gas is being emitted.

For example, 1 ton of methane (CH₄) warms the planet 28 times more than 1 ton of CO₂ over 100 years, so 1 ton of methane is equivalent to 28 tons CO₂e.

What is a Metric Ton?

GHG emissions are usually measured in MTs, which is the standard unit used around the world.

1 MT = 1,000 kilograms

What is equivalent to 1 million metric tons of CO₂ (MMT CO₂e)?



What is carbon sequestration?

Sequestration is the process of capturing carbon dioxide from the atmosphere (or from emission sources) and storing it so that it does not contribute to climate change. The goal of increasing sequestration is to reduce the amount of CO₂ in the atmosphere, helping slow down climate change. There are two main types:

- **Natural sequestration:** Forests and soil naturally absorb CO₂. For example, trees take in CO₂ during photosynthesis.
- **Technological sequestration:** Methods that capture CO₂ from power plants, industrial facilities, or directly from the air and store it underground or use it in products.

Gross vs. Net GHG Emissions

- Gross GHG emissions are the total emissions released into the atmosphere from activities like burning fossil fuels, agriculture, or industrial processes.
- Net GHG emissions take that gross number and subtract any CO₂ that is removed (or "sequestered") from the atmosphere through natural or technological means.
- When reporting emissions, both gross and net figures are important. Gross emissions show the amount of GHGs released into the atmosphere, while net emissions reflect how much is sequestered. The net amount of GHGs is an important metric for assessing rising global temperatures and climate change impacts. Many climate targets, including this plan's goal, focus on net emissions (e.g., achieve net zero emissions by 2050), aiming for a balance between emissions produced and emissions removed.

Scope 1, 2, and 3 GHG Emissions Reporting

Scopes are a way to categorize GHG emissions based on where they come from and who controls them. They are a standard reporting structure used in GHG inventories to help entities understand and track emissions. This report primarily focuses on Scope 1 and 2 emissions in the Richmond MSA.



Scope 1 (Burn): Direct emissions from *burning* fuel — like in vehicles or gas furnaces for building heating systems.

Scope 2 (Buy): Indirect emissions from the electricity we *buy*, representing the carbon intensity of the resources used to produce it.

Scope 3 (Beyond): Indirect emissions that go *beyond* our operations, also called “upstream” emissions.

What are co-pollutants – and why do they matter?

When we reduce GHG emissions — especially from burning fossil fuels — we also reduce other harmful air pollutants that affect local air quality and health. These are called co-pollutants. When we take climate action (like switching to clean energy or reducing car traffic), we also cut co-pollutants. This means cleaner air, healthier communities, fewer hospital visits and missed days of work and school, and greater benefits to overburdened communities, which often face the highest pollution levels.

There are two main categories of co-pollutants:

- **Hazardous Air Pollutants (HAPs):** Also known as air toxics, these pollutants are known or suspected to cause cancer, birth defects, or serious health problems. Examples include benzene, formaldehyde, and mercury.
- **Criteria Air Pollutants (CAPs):** These are six common air pollutants regulated by the U.S. EPA because they harm human health and the environment: particulate matter (PM_{2.5} and PM₁₀) – tiny particles that can enter the lungs and bloodstream; ground-level ozone (O₃) – formed when other pollutants react in sunlight and can worsen asthma; nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) – cause respiratory issues and smog; carbon monoxide (CO) – reduces oxygen delivery in the body; and lead (Pb) – toxic to the brain and nervous system, especially in children.

Impacts of Climate Change in the Region

The Richmond region is already experiencing the effects of a changing climate, and these impacts are expected to intensify in the coming decades. Rising temperatures, shifting precipitation patterns, and sea level rise are affecting the region's communities, infrastructure, economy, and ecosystems in interconnected ways.

Rising Temperatures and Extreme Heat

Average temperatures across Central Virginia have increased significantly over the past century, and projections indicate continued warming through 2070 and beyond. Richmond's annual average daily maximum temperature, which was approximately 68.5°F during the 1961–1990 period, could rise to as high as 77°F under a high-emissions scenario⁵. This shift represents a substantial increase in both average heat and the number of extremely hot days each year.

Currently, the Richmond metropolitan area experiences about 72 days each year with temperatures exceeding 90°F and roughly 24 days exceeding 100°F. Within the next three decades, those figures could climb to more than 90 and 40 days respectively⁶. These trends mean that heat once considered extreme will become increasingly common.

Extreme heat has widespread consequences. It is one of the most dangerous weather-related hazards, contributing to higher rates of respiratory and cardiovascular distress – especially among older adults, young children, pregnant individuals, outdoor workers, and those experiencing homelessness. Hospitals and emergency rooms across the region are already seeing rising numbers of heat-related illnesses. Prolonged heat also places additional stress on infrastructure by degrading pavement, warping rail tracks, and increasing energy demand for cooling, which can strain the electrical grid during peak summer months.

Shifting Precipitation and Flooding Risks

The region's climate is becoming wetter, particularly in the winter and spring months. Climate change causes the atmosphere and surface bodies of water to be warmer on average. These higher temperatures supercharge the water cycle, causing storms to drop more water in shorter amounts of time. Average winter precipitation in the region could increase by up to 15% by the 2080s⁷, and the number of extreme precipitation events is projected to grow as well⁸. While overall precipitation is increasing, rainfall is occurring in heavier bursts, leading to greater flooding potential and more runoff in urbanized areas.

⁵ A high emissions scenario refers to a Shared Socio-economic Pathway (SSP) that represents the upper boundary of radiative forcing (for example, SSP5-8.5 represents a pathway with an additional radiative forcing of 8.5 W/m² by 2100). Under a high emissions scenario, there is intensified exploitation of fossil fuel resources and a more energy-intensive global lifestyle (Böttinger, M. and Kasang, D. The SSP Scenarios. Deutsches Klimarechenzentrum.)

⁶ First Street Risk Factor: <https://firststreet.org/?from=riskfactor.com>

⁷ This statistic assumes a blended scenario, which refers to a scenario which uses a combination of moderate and high global emissions scenarios.

⁸ Extreme precipitation events are defined as events with more than 2 inches of precipitation in 24 hours.

The Richmond area has a long history of river and flash flooding, but these events are becoming more intense and less predictable. Heavy downpours can overwhelm stormwater systems, erode stream banks, and damage roads, bridges, and homes. Low-lying neighborhoods and communities along creeks and tributaries are particularly vulnerable.

Although the Richmond region is not located directly on the coast, sea level rise is also a growing concern. Due to post-glacial rebound – a geologic process that causes land along the mid-Atlantic coast to gradually sink—Virginia is experiencing sea level rise at a rate higher than the global average⁹. While global sea levels have risen about 7–8 inches since 1880, levels along the Virginia coast have increased by 17 inches between 1930 and 2020. By 2100, projections suggest an additional rise of one to four feet globally. Rising tides and storm surges are already pushing saltwater farther up the James and York Rivers, resulting in increased erosion, wetland loss, and saltwater intrusion in riverside communities. Farmland and properties in Prince George, Charles City, New Kent, King William, and King and Queen counties are particularly at risk.

Drought and Agricultural Impacts

While precipitation is increasing overall, climate change is also driving more variability, meaning dry periods may become more frequent and last longer between heavy rain events. Extended droughts can reduce crop yields, stress livestock, and threaten local water supplies. For the region's agricultural communities, which contribute significantly to the local economy and cultural heritage, this volatility creates both economic and environmental challenges.



Chesterfield Farmers Market. Source: Chesterfield County

Ecological and Biodiversity Impacts

The region's natural systems are influenced by the changing climate, too. Warmer temperatures and altered precipitation patterns create conditions that favor invasive species and pests while placing stress on native plants and animals. Species such as fire ants, which previously could not survive Virginia's winters, are now expanding northward. Hotter summers also warm the region's rivers and streams, reducing dissolved oxygen levels, harming fish populations, and promoting harmful algal blooms that degrade water quality and can sicken recreational users.

The combined effects of heat, drought, flooding, and invasive species threaten the health of forests, wetlands, and waterways – ecosystems that provide essential services such as flood control, water filtration, and carbon storage. For more information on how climate change impacts the region, see the [2025 Virginia Climate Assessment](https://www.georgetownclimatecenter.org/2025-virginia-climate-assessment/) from Georgetown Climate Center.

⁹ Woods Hole Oceanographic Institution. 2018. Why is Sea Level Rising Faster in Some Places Along the U.S. East Coast Than Others? <https://www.whoi.edu/press-room/news-release/why-is-sea-level-rising-higher-in-some-places-along-u-s-east-coast-than-others/>

Progress in the Region

Although the Pathways to the Future: Air Quality Plan is the first regional climate-focused plan for Central Virginia, localities and community partners have long been working to reduce emissions, improve air and water quality, and build long-term sustainability. These initiatives demonstrate the region's commitment to climate action. This plan is propelled by that momentum.

One of the most visible examples of progress is the City of Richmond's RVAgreen2050 plan for equitable climate action. This comprehensive strategy outlines forty-six coordinated approaches for achieving a climate-neutral and climate-resilient city. The plan integrates emissions reduction, community resilience, equity, and environmental stewardship, and it has driven new investments and cross-departmental initiatives that support cleaner transportation, healthier homes, greener infrastructure, and climate-aware development practices. RVAgreen2050 is one of the most ambitious climate frameworks in the region and serves as a model for local planning. The City has implemented sustainable design standards and expanded energy management improvements through its Joint Energy Team, while also participating in national programs such as the Department of Energy's Better Climate Challenge to drive deeper emissions reductions. Richmond has also taken meaningful steps to reduce waste by adopting a plastic bag tax, which supports litter reduction and environmental cleanup efforts. In addition, the City earned [national recognition](#)¹⁰ for its forward-looking electric vehicle policies, reflecting its leadership in expanding charging infrastructure and modernizing transportation systems. Together, these achievements underscore Richmond's ongoing commitment to clean energy, responsible resource management, and innovative climate solutions.

Henrico County continues to demonstrate strong regional leadership in sustainability and public-sector innovation. The county has already begun work to develop their own Climate Action and Adaptation Strategy, which will be aligned with the regional Air Quality Plan. The goal will be to define what is possible within the county's operations, as well as to provide community-focused mentoring and leadership in this important area. Henrico has also invested heavily in expanding and protecting its tree canopy, recognizing the essential role that healthy forests play in improving air quality, reducing urban heat, and strengthening resilience. Henrico's sustained commitment to tree planting—through public works, community partnerships, and development standards—has helped preserve mature forests while restoring wooded areas in neighborhoods, parks, and public facilities. These efforts reinforce the county's long-term vision for conserving green space and supporting the ecological health of its growing communities.

Henrico has paired its forest conservation work with substantial investments in energy efficiency and renewable energy. The county's portfolio of solar projects continues to grow, reducing operational emissions and lowering long-term energy costs for schools and government buildings. Energy management tools such as EnergyCAP help staff track electricity and fuel use across hundreds of facilities, enabling data-driven upgrades and targeted efficiency improvements. By integrating clean energy deployment with rigorous energy monitoring, Henrico has built a strong foundation for achieving deeper emissions reductions in the years ahead.

¹⁰ <https://rva.gov/press-releases-and-announcements/news/richmond-earns-national-recognition-electric-vehicle-policies>

Chesterfield County has made meaningful progress in advancing environmental stewardship, efficient public services, and long-term sustainability.

Chesterfield continues to enhance community wellbeing through the Chesterfield County Farmers Market and a thriving community garden program at Rockwood Park. The county has also collaborated with CVWMA (along with Henrico and the City of Richmond) to expand food-scrap composting. These projects help connect residents with fresh, locally grown produce



Solar on the Chesterfield Fleet Services building. Source: Chesterfield County

and help cultivate a culture of healthy, sustainable living. The county continues to modernize its building stock with energy-efficient systems and purchasing clean, solar power for its municipal buildings and schools. Chesterfield is also investing in resilient infrastructure and advanced planning efforts that support clean energy, efficient transportation, and responsible growth. Its participation in regional partnerships – including construction of the Fall Line Trail, watershed protection, and climate-focused planning – demonstrates Chesterfield’s commitment to coordinated action and long-term community wellbeing.

Across the Richmond metropolitan area, every locality is contributing to measurable progress in emissions reduction, waste diversion, and environmental stewardship. While this chapter highlights several major initiatives, the full scope of work underway across the region is far more extensive than can be summarized here. Counties, towns, and cities throughout the MSA are implementing new waste-reduction programs, expanding access to clean energy, restoring natural areas, and protecting green spaces through tree planting, riparian buffers, park projects, and open-space preservation. These efforts reflect the shared commitment of local governments to build cleaner, healthier, and more resilient communities, regardless of size or geography.

PlanRVA plays an essential role in supporting this momentum through its multi-jurisdictional planning and coordination efforts. The organization leads regional initiatives focused on water quality, waste reduction, climate resilience, and active transportation—areas where collaboration across local boundaries drives the greatest impact. PlanRVA is also a key partner in the RVA Rising initiative, which advances equitable economic opportunity across the region. Climate action and economic wellbeing are intricately linked. The transformation to a clean energy economy provides opportunities to serve the goals of Richmond Rising. The Air Quality Plan is intentionally aligned with other ongoing regional efforts—including the Natural Resources Plan (currently in development), the Comprehensive Economic Development Strategy (CEDS), the Long-Range Transportation Plan (LRTP), and other cross-sector strategies—to ensure that climate action is integrated, durable, and mutually reinforcing.

Localities across the region, working alongside PlanRVA and partner PDCs, have advanced a suite of transportation initiatives that strengthen regional mobility while laying a solid foundation for future action under this Air Quality Plan. In 2008, PlanRVA launched a pilot project to connect the Port of Hampton Roads with the Richmond Marine Terminal via barge service along the James River—a program that has since expanded and now reduces CO₂ emissions by an estimated 40–50% by shifting freight off Interstate 64. At the same time, localities are helping to build out a regional bike and pedestrian network that provides safe, non-motorized travel options. Three major spine trails are central to this system: the Virginia Capital Trail,

completed in 2015, which links Richmond through Henrico and Charles City Counties to Jamestown; the Appomattox River Trail, a 25-mile corridor traversing six localities and complemented by conservation and riparian restoration projects; and the Fall Line Trail, a transformative north-south connection tying Ashland and Hanover County to the Virginia Capital Trail and the Appomattox River Trail through Henrico, Richmond, Chesterfield, and Petersburg. Transit and materials management partners are likewise advancing regionwide progress: GRTC has adopted a Zero-Emission Bus Plan and is preparing for a full transition to electric vehicles while pursuing permanent zero-fare service, and the Central Virginia Waste Management Authority is expanding compost access and targeting an 80% regional recycling rate by 2050. Together, these collaborative efforts demonstrate how regional institutions and local governments are driving meaningful, system-wide changes to improve mobility, equity, and air quality across Central Virginia.

State and federal leadership also play important roles in advancing climate progress locally. Virginia's Comprehensive Climate Action Plan provides a statewide framework that will bolster local goals. The Commonwealth recently received major implementation awards for a Methane Reduction Program which will support expanded composting at universities and new methane-capture projects at waste facilities. Other state agencies, such as the Department of Conservation and Recreation (DCR) and the Department of Wildlife Resources (DWR), continue to advance climate-smart programs focused on agricultural soil health, watershed protection, and wildlife habitat restoration. These statewide efforts strengthen and accelerate the work happening in localities across the region, helping ensure that Central Virginia is well-positioned to meet long-term climate and environmental goals.

Together, these accomplishments reflect a region that is not starting from scratch but instead building on a strong foundation of innovation, leadership, and collaboration. The Air Quality Plan recognizes and celebrates these successes while charting the next steps for expanding this momentum across Central Virginia.



Cyclists on the Virginia Capital Trail. Source: PlanRVA

Regional Emissions Inventory

Emissions inventories help to inform which sectors should be prioritized during GHG reduction planning. The inventory was compiled for 2022 – our ‘baseline’ year - and assesses GHG sources and sinks across six key sectors: transportation, residential and commercial buildings, electric power use, industry, solid waste and wastewater, and natural & working lands.

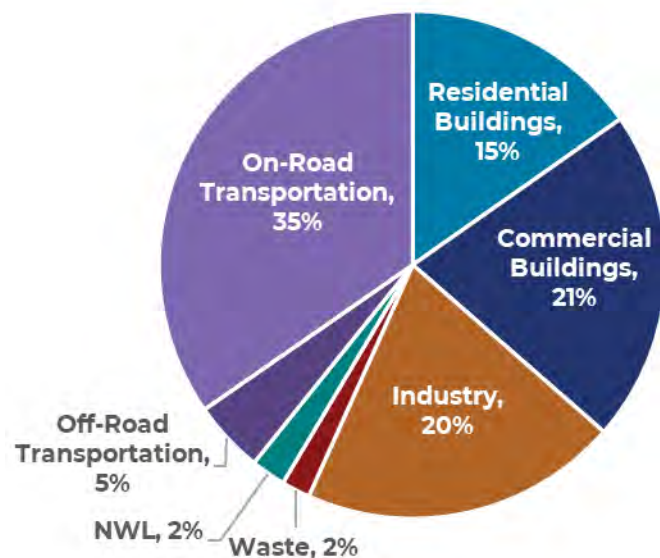
2022 GHG Summary

The 2022 GHG inventory is a comprehensive assessment of GHG emission sources and sinks across the MSA. The inventory was developed using a consumption-based (Scope 1 and 2) approach, which accounts for electricity consumed within the region in addition to direct sources of emissions, such as the combustion of fossil fuels in vehicles or buildings. The industry sector includes both energy use in industrial buildings and emissions associated with industrial processes. The inventory is also presented in terms of both gross and net emissions. Gross reporting reflects sources of emissions only, while net emissions consider carbon sinks, such as the carbon stored in forests and wetlands. Total gross emissions in 2022 were **21.9 MMTCO₂e**. When accounting for the value of carbon stored in regional sinks, total emissions decline to **16.9 MMTCO₂e**, with over 5 MMTCO₂e sequestered in regional natural lands – primarily forests and urban trees.

Within the region, emissions vary largely across localities. Those with large populations, high employment, and commercial or industrial activities produce higher levels of emissions. Less densely populated areas may also benefit from greater carbon sinks due to forest or grasslands. The highest emitting localities in the region are Chesterfield, Henrico, Hanover, and Richmond, which are also the largest centers of population and economic activity. Chesterfield, Dinwiddie, Sussex, and Hanover have the highest value of carbon sinks from natural lands. While urban areas have higher total emissions due to their density and activity levels, they also tend to have lower per-person emissions compared to more spread-out areas.

GHG inventories are complex and imperfect. However, they arm us with information on the greatest sources of air pollution and allow us to track progress.

Figure 2: Richmond MSA Gross Consumption-Based (Scope 1 & 2) GHG Inventory, 2022



Key Findings

- Total gross emissions in 2022 were 21.9 MMTCO₂e, and total net emissions were 16.9 MMTCO₂e.
- The largest sources of emissions are on-road transportation, buildings, and industry.
- The largest categories of CO₂ sink in the region from natural lands are forest (~4.6 MMTCO₂e sequestered) and urban trees (~0.4 MMTCO₂e, sequestered). The region's natural lands are key to help offset emission sources and also provide significant health and climate resilience benefits.

Co-Pollutant Inventory

There are many more air pollutants that impact public health than the six greenhouse gases tracked in the inventory above. CAPs are a class of pollutants that harm public health and the environment, and HAPs are known to cause cancer and other serious health impacts. CAP and HAP emissions generally accompany greenhouse gas emissions. Reducing GHGs therefore also reduces CAPs and HAPs. Like a GHG inventory, tracking these co-pollutants over time provides an understanding of what pollutants are being released, how much, and key sources of them.

- **CAPs** include ozone, particulate matter (PM_{2.5}, PM₁₀), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and lead.
- **HAPs**, also known as air toxics, include over 180 chemicals such as benzene and mercury.

In addition, there are many types of pollutants that relate to both CAPs and HAPs, or that are considered a precursor pollutant that may react with other pollutants to form either a CAP or HAP and are thus important to track for air quality assessments.

- **Volatile organic compounds** (VOCs) are gases that come from things like fertilizer use in agricultural activities, paints, varnishes, cleaning supplies, gasoline and diesel, and building materials. When VOCs react with nitrogen oxides, they create ozone, a CAP. Some VOCs are HAPs, such as benzene or formaldehyde.
- **Ammonia** (NH₃) contributes to the formation of PM_{2.5}, a CAP, when it reacts with other pollutants like NO_x and SO₂.

Table 1 provides a summary of co-pollutant emissions in the region by sector and pollutant, with a focus on criteria pollutants. The data is compiled from EPA's 2022 Emissions Modeling Platform.

Table 1: Richmond MSA Co-Pollutant Emissions (Metric Tons), 2022

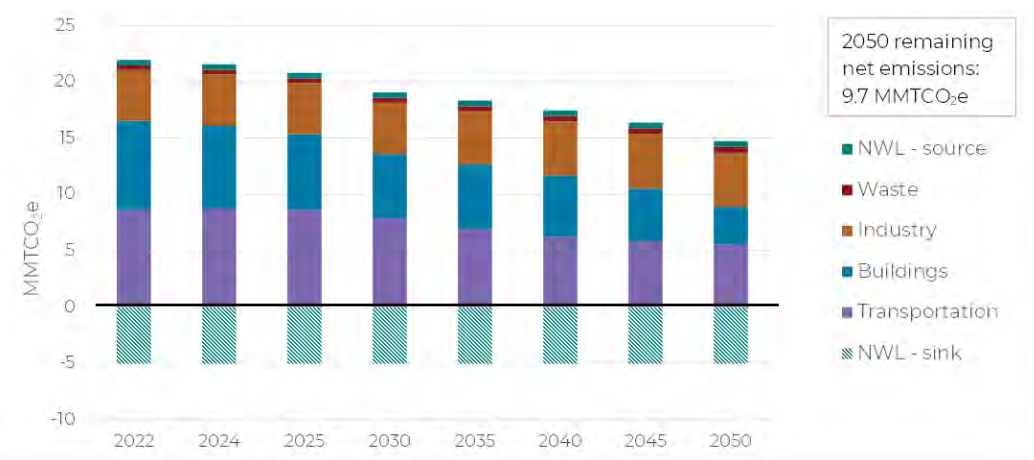
Category	CO	NO _x	VOC	PM ₁₀	PM _{2.5}	SO ₂	NH ₃
Agriculture	19,362	1,424	96,523	3,987	2,146	121	3,496
Industrial Processes	2,640	2,545	11,967	7,098	1,922	757	638
Transportation	101,098	10,746	6,609	940	488	64	818
Buildings	15,113	6,772	1,985	4,055	3,791	482	416
Waste	8,629	409	1,492	1,350	1,165	214	595
Other	327	8	83	4,189	772	1	-
Total	147,170	21,902	118,659	21,618	10,285	1,638	5,962

GHG Business as Usual Projections

A business-as-usual (BAU) GHG emission projection scenario illustrates how the region's emissions might look in the future without additional action. The BAU scenario reflects future emissions under state and federal policies in place at the time of writing this report. It also considers historical trendlines and expected growth factors such as changes in population and employment. The BAU scenario serves as a basis against which we can compare emission reduction benefits from implementation of possible GHG reduction measures.

Figure 3 shows the region's GHG emission projections by sector. Compared to the 2022 inventory base year, the BAU forecasts that net GHG emissions will decline 22% by 2035, and over 40% by 2050.

Figure 3. Richmond MSA GHG Emissions by Sector: BAU Scenario



The transformative impact of the Virginia Clean Economy Act (VCEA) is a primary driver of the emissions reductions in this scenario. The VCEA shifts the source of electricity on the grid away from fossil fuels which means that increased electrification in the transportation and buildings sectors reduces overall emissions, instead of just shifting emissions to the power generation sector.

The Richmond MSA should aim to keep pace with the BAU projections through 2035. Achieving a 22% decrease in emissions within 10 years will be important for setting the region up for success in the long term. It is important to remember that *any amount of GHG reduction is valuable and reaps benefits to our communities.*

Key Findings

- By 2050, **transportation** sector emissions are projected to decline 38% from 2022 levels driven by improved vehicle fuel efficiency and increased electric vehicle adoption.
- By 2050, **building** sector emissions are expected to decline by over 40% from 2022 levels. These reductions are largely driven by state mandates for a net zero emissions electric power sector by 2050. Through 2050, the BAU assumes a cleaner electricity generation mix, which leads to lower emissions associated with electricity use in buildings. In addition to the cleaner electricity mix, ongoing trends towards more energy efficient building appliances and equipment drive emission reductions.
- Emissions from the **waste** sector are projected to rise slightly as population growth increases overall waste generation.
- Emission from the **industrial** sector are projected to rise slightly as well based on increased economic employment projections.
- For the **NWL** sector, emissions from agriculture are expected to grow slightly based on historical trends tied to livestock populations. Carbon sequestered in natural lands is expected to remain constant in the BAU.

GHG Measures



Identified GHG Reduction Measures

This section presents a menu of GHG reduction measures designed to guide action across the region. The measures reflect a broad range of strategies—some ready for immediate implementation and others requiring further exploration or collaboration. Measures do not apply equally to every locality, organization, or partner, and the responsibility for achieving emissions reductions does not rest solely with local governments. While many partners have a role to play, local governments are uniquely positioned to lead by example and set the tone for broader community action. Together, these actions represent shared opportunities for residents, businesses, institutions, and agencies to contribute to a more sustainable, resilient, and low-carbon future. This section provides an overview of the measures, the authority to implement them, potential funding sources, and the GHG reduction potential through 2050 if they are fully implemented.

Table 2: List of GHG Reduction Measures

#	Measure Description	Sector
B1	Invest in energy efficiency, electrification, and other improvements for municipal and school buildings.	Buildings
B2	Increase resident education and awareness of utility, state, and federal incentives for energy efficiency home improvements and electric appliances.	Buildings
B3	Increase energy efficiency in existing commercial and industrial buildings through financial incentives and educational outreach programs.	Buildings
B4	Encourage the design, building, and operation of residential, commercial, and industrial buildings above the current required code.	Buildings
E1	Support the adoption of distributed renewable energy resources.	Energy
E2	Support the development of grid-scale clean energy development and utility efforts to enhance grid resiliency.	Energy
I1	Support local production and use of low-embodied carbon materials through clean procurement frameworks.	Industry
I2	Support emissions reductions from industrial processes.	Industry
NWL1	Remove carbon through nature-based solutions, land preservation, and climate-smart land use management	Natural & Working Lands
NWL2	Support and incentivize shared land use with renewable energy and agricultural activities.	Natural & Working Lands
NWL3	Expand urban agriculture and develop region-wide and inter-regional food system distribution.	Natural & Working Lands
NWL4	Increase equitable tree canopy coverage and access to public green spaces.	Natural & Working Lands
NWL5	Increase soil conservation and nutrient management practices in agriculture.	Natural & Working Lands

#	Measure Description	Sector
NWL6	Support livestock management strategies that reduce emissions.	Natural & Working Lands
T1	Reduce emissions from port operations through the adoption of low-carbon fuels, electric equipment, and operational changes.	Transportation
T2	Support and incentivize the rapid adoption, equitable installation, and use of zero-emission vehicles.	Transportation
T3	Expand equitable transit access.	Transportation
T4	Reduce vehicle miles traveled through micromobility options and active transportation.	Transportation
T5	Expand use of low-carbon transportation materials	Transportation
W1	Decrease amount of waste sent to landfills.	Solid Waste and Wastewater
W2	Support a local, circular economy.	Solid Waste and Wastewater
W3	Support efficiency upgrades at wastewater treatment plants.	Solid Waste and Wastewater

Authority to Implement

The Air Quality Plan is a community effort that relies on the participation and cooperation of local governments, businesses, non-governmental organizations, and residents. In many cases, public and private partners will need to collaborate to effectively implement measures. Every measure includes near-term actions where localities have clear authority to implement. Other actions need to be addressed at the state level. Virginia localities are restricted to powers explicitly granted by the General Assembly (the “Dillon Rule”¹¹). The following is a sector-by-sector summary of implementation powers.

Buildings

State agencies define the code framework; localities operationalize it through implementation, voluntary initiatives, and public leadership; and private building owners are the key implementers of energy and carbon reduction improvements. Building energy codes in Virginia are established by the Virginia Department of Housing and Community Development (DHCD) and enforced uniformly across the state; localities cannot mandate stricter energy standards than those set by the state. Nonetheless, local governments can leverage their authority over zoning, permitting, contracting, and municipal building operations to reduce emissions in this sector. They can implement voluntary programs, demonstration projects, and incentives to encourage energy efficiency and electrification. Local governments can lead by example by adopting high-performance standards for public buildings.

Private building owners, property managers, and developers are the primary implementers of building energy improvements. They voluntarily participate in incentive programs, green building certifications, and energy benchmarking initiatives that go beyond minimum code requirements. Commercial and multifamily building owners can play a leading role by pursuing high-performance design and retrofits, electrification of heating

¹¹ https://www.cvillepedia.org/Dillon_Rule

systems, and installation of renewable energy technologies, often supported by state and federal incentives. Their participation is essential for achieving deep emissions reductions in the buildings sector. Federal agencies such as the Department of Energy (DOE) and EPA provide incentives, grants, and model code support through programs such as ENERGY STAR and Home Energy Rebate Programs.

Energy

In Virginia, state regulators and utilities hold primary authority over grid-scale energy planning and operation, while local governments influence siting, zoning, and community acceptance. At the state level, Virginia Energy plays a key role in advancing both distributed solar and grid-scale clean energy through policy development, incentive programs, and technical support. The SCC regulates utility planning and approves large-scale energy projects, including renewable energy generation and grid infrastructure.

Building owners, developers, and residents are the key implementers of rooftop and distributed solar, and local policies—such as streamlined permitting, financing assistance, and outreach—can substantially accelerate adoption. Effective clean-energy progress depends on alignment and cooperation across all levels: state and federal agencies set the framework; utilities and developers deliver infrastructure; and local governments and communities create the enabling environment for adoption.

Industry

State and federal authorities set regulatory and funding frameworks; local governments influence siting and partnerships; and industrial facilities themselves are the main implementers of emission-reduction actions through voluntary participation and investment in cleaner operations. Industrial facility owner and operator participation in decarbonization efforts is largely voluntary, unless required by specific air quality or permitting regulations. Companies may engage in energy efficiency upgrades, process improvements, fuel switching, and renewable energy use through voluntary or incentive-based programs. Industry partnerships with utilities, local governments, and technical assistance programs are key to scaling adoption of clean manufacturing practices.

The U.S. Environmental Protection Agency (EPA), VDEQ, and the Virginia Department of Energy (Virginia Energy) are the primary regulators of this sector. The EPA and VDEQ regulate air emissions and manage environmental permitting, while Virginia Energy supports industrial decarbonization through energy efficiency programs, technical assistance, and clean energy initiatives. Local governments can play a supporting role through land use planning, local incentives, and partnerships with industry to encourage voluntary emissions reductions.

Natural & Working Lands

Local governments have authority over land use, zoning, and conservation, allowing them to implement projects that protect public health, natural resources, and community well-being. This includes initiatives like agrivoltaics, pollinator-friendly solar, and shared land use projects, which may require approval from local legislative or administrative bodies, particularly when public funding or zoning changes are involved. Private landowners and farmers will also need to opt into programs and work collaboratively with localities to implement many of the measures.

Coordination with state agencies is necessary when projects affect state lands or require technical or regulatory support. Local governments, along with agricultural agencies and conservation districts, also play a role in advancing local food systems, urban agriculture, and farm-to-school programs, often in collaboration with community partners.

Transportation

Local governments drive community-scale infrastructure and policy changes, while state and federal agencies control funding, fuel standards, and major transportation planning frameworks. Local governments have the authority to procure vehicles for public fleets and can support emissions reductions by adopting low- and zero-emission vehicle (ZEV) procurement policies within the requirements of the Virginia Public Procurement Act. Private vehicle choices are not regulated, but local jurisdictions can adopt zoning, building codes, and policies that support EV charging infrastructure, thereby making EVs a more attractive choice for consumers. Actions related to public transit systems may require coordination from regional or state transportation agencies. Localities can expand pedestrian and bicycle infrastructure and update zoning codes, transportation plans, and street design standards. Additionally, employers can contribute by implementing telework policies and encouraging transit use, often supported by local or regional programs.

Solid Waste and Wastewater

County government agencies, in partnership with regional waste authorities, utilities, landfills, and composting facilities, have the authority to implement waste management projects. Local governments play the central role in managing solid waste and wastewater systems, both of which offer opportunities to reduce GHG emissions. Some localities contract with the Central Virginia Waste Management Authority (CVWMA), a regional entity, for waste management services. For solid waste, localities can implement policies and programs that promote diversion from landfills—including reduction, reuse, recycling, and composting—to reduce methane emissions from decomposing organic material. While landfills are regulated by the VDEQ, local governments can support methane capture projects, adopt waste diversion goals, and work with regional authorities, like CVWMA, and the private sector to improve waste infrastructure. Wastewater utilities and public works departments can reduce emissions through energy efficiency upgrades, methane capture, and improved treatment processes. Coordination with state agencies, especially VDEQ, is often required for infrastructure improvements, permitting, and funding.

Funding Sources

The following section identifies potential funding sources by sector for implementation of the GHG reduction measures. While this section focuses primarily on federal and state programs, additional support may also be available through utilities, green banks, philanthropic organizations, and public-private partnerships. Many of the listed programs can be combined to finance projects that deliver multiple co-benefits, such as improved air quality, resilience, and community well-being. Access to funding will vary depending on the scale of the project, the eligible applicant (e.g., local government, nonprofit, business, or regional entity), and the ability to provide matching funds or meet technical criteria. Effective implementation often depends on coordinating multiple funding streams to achieve complementary outcomes.



Public charging station in downtown Richmond. Source: City of Richmond

Federal Funding Uncertainty

Federal programs provide the largest source of climate and infrastructure funding but are subject to future budget appropriations and policy shifts. Administrative actions or changes in federal priorities may alter program timelines, eligibility criteria, or available funding. Maintaining diversified and flexible financing strategies is imperative. Many key initiatives, such as those created under the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA), have been terminated by the current federal administration, although court cases regarding these actions are still underway. Given continued uncertainty of federal programs, potential applicants should verify program status, eligibility, and available funding and consider alternative financing mechanisms to mitigate risk from potential reductions or pauses in federal support.

Leveraging Partnerships and Blended Finance

Few large projects can be fully funded by a single source. Successful implementation often depends on *blended finance*, which means combining grants, loans, tax credits, and private capital to meet total funding needs.

Public-private partnerships (P3s) and green bank financing can fill remaining gaps, especially for distributed energy, fleet electrification, and building retrofit projects that yield long-term cost savings. Utilities and regional agencies can leverage their size and multi-jurisdictional nature to channel investments to shared projects that benefit multiple communities. In addition, philanthropic and community-based funding can provide complimentary resources to support community engagement and outreach and on-the-ground implementation. Localities and nonprofits should work together to compete collectively for larger awards. Together, these funding strategies can create a resilient foundation for long-term implementation of the measures.

Buildings, Energy, and Industry

Energy efficiency, electrification, clean energy, and industrial decarbonization measures can be funded through a mix of DOE, EPA, and state-level programs, as well as tax incentives, utility rebates, and financing mechanisms such as Property Assessed Clean Energy (PACE). These resources are applicable across building, energy, and industry measures (B1–B4, E1–E2, I1–I2).

Example potential funding sources include:

- U.S. Department of Energy (DOE) – Energy Efficiency and Conservation Block Grant Program (EECBG)
- DOE – Home Efficiency Rebates and Home Electrification and Appliance Rebates
- DOE – State Energy Program
- DOE and State Agencies – Weatherization Assistance Programs
- DOE – Grid Innovation Program
- DOE – Smart Grid Grants
- DOE – Grid Resilience and Innovation Partnerships (GRIP) Program
- U.S. Department of Health and Human Services (DHHS) – Low Income Home Energy Assistance Program (LIHEAP)
- IRA – Energy Efficient Commercial Buildings Deduction (Section 179D) and New Energy Efficient Home Credit (Section 45L)
- Virginia PACE – Commercial and residential energy efficiency financing

- Virginia Clean Energy Innovation Bank – Low-cost financing for clean energy and efficiency projects
- Virginia Grid Reliability Improvement Program
- Virginia Community Access to Renewable Energy Funding
- Utility Energy Efficiency and Electrification Programs

Collectively, these resources can support local and private-sector implementation of energy efficiency retrofits, electrification, distributed solar deployment, grid modernization, and industrial process improvements. Many programs prioritize projects that reduce emissions while improving grid resilience and energy affordability.

Home Energy Rebates for Consumers

Created under the Inflation Reduction Act (IRA), the Home Energy Rebates initiative provides two complementary programs designed to help households reduce energy use and lower costs. The **Home Efficiency Rebate Program (HOMES)**[†] rewards whole-home energy upgrades such as insulation, air sealing, and equipment replacement based on verified energy savings. The **Home Electrification and Appliance Rebates (HEAR)**[†] program offers point-of-sale rebates for replacing fossil-fuel appliances with efficient electric alternatives like heat pumps for space heating and cooling, heat pump water heaters, and induction cooktops.

[†] - Virginia is awaiting approval from USDOE to proceed with the program launch of HOMES and HEAR.

Natural & Working Lands

Projects that protect and restore natural resources are eligible for a range of federal and philanthropic grants for conservation grants and environmental education. State programs in Virginia complement these efforts by supporting community forestry, watershed protection, and reforestation.

Example potential funding sources include:

- United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) – Healthy Forests Reserve Program
- National Forest Foundation – Grant Programs for forest restoration and community engagement
- U.S. Forest Service – Urban and Community Forestry Grants
- Virginia Department of Forestry (DOF) – Trees for Clean Water Grant Program
- Virginia DOF– Forest Pest Treatment Cost-Share Programs
- Virginia DOF – Community Forest Revitalization Program
- NOAA Chesapeake Bay–Watershed Education and Training (B-WET) Program
- Chesapeake Bay Trust – Environmental Education Grant Program
- Virginia Department of Conservation and Recreation (DCR) – Watershed Educational Programs Project

Many of these programs can fund land use planning (NWL1), tree planting (NWL4), and soil conservation (NWL5).

Transportation

Transportation decarbonization projects such as fleet electrification, transit expansion, EV charging infrastructure, and active transportation investments are supported by numerous federal transportation and energy programs, often administered through state departments of transportation or metropolitan planning organizations (MPOs). Many require local match funds or alignments with regional transportation improvement plans.

Example potential funding sources include:

- Federal Transit Administration (FTA) – Urbanized Area Formula Program
- FTA – Bus and Bus Facility Grants
- FTA – Capital Investment Grants
- Federal Highway Administration (FHWA) – Carbon Reduction Program
- FHWA – Congestion Mitigation and Air Quality Improvement (CMAQ) Program
- FHWA – Highway Safety Improvement Program (HSIP)
- FHWA – Surface Transportation Block Grant (STBG) Program
- FHWA – National EV Infrastructure (NEVI) Formula Program
- FHWA – Charging and Fueling Infrastructure Discretionary Grants
- EPA – Clean School Bus Program
- EPA – Diesel Emissions Reduction Act (DERA) Program
- EPA – Clean Heavy-Duty Vehicle Program
- FTA – Low or No Emission Vehicle Grant Program
- IRA – Alternative Fuel Vehicle Refueling Property Tax Credit
- USDA – Rural Energy for America Program (REAP): Renewable Energy Systems & Energy Efficiency Improvement Loans & Grants
- Virginia Department of Rail and Public Transportation (DRPT) – Transit and multimodal funding programs
- Virginia Commuter Assistance Program (CAP)
- Virginia Ridership Incentive Program (VRIP)

Together, these funding streams can support T1 (adopt low carbon fuels and electric equipment for port operations), T2 (EV adoptions), T3 (expand equitable transit access), T4 (micromobility and micro-modal infrastructure), and T5 (expand use of low-carbon transportation materials) measures at the local and regional scale.

Solid Waste and Wastewater

Waste reduction, recycling, and wastewater efficiency projects can draw from both EPA and USDA programs, supplemented by state-level recycling, litter prevention, and infrastructure grants. The CVWMA can also leverage federal and state programs for solid waste diversion.

Example potential funding sources include:

- EPA – Solid Waste Infrastructure for Recycling Grant Program

- EPA – Consumer Recycling Education and Outreach Grant Program
- USDA – Solid Waste Management Grants
- USDA – REAP Guaranteed Loans and Grants
- Virginia DEQ – Litter Prevention and Recycling Grants

Additional opportunities may arise through Clean Water State Revolving Funds (CWSRF) for wastewater infrastructure improvements, particularly projects that incorporate methane capture, energy efficiency upgrades, or resource recovery systems.

Philanthropic and Nonprofit Partnership Funding Opportunities

These opportunities are often available to nonprofit organizations or require partnerships between government entities and nonprofits or community-based organizations (CBOs) to be eligible. This is a partial list of medium-to-large size funding opportunities that tend to be offered year after year. There are many more funding opportunities beyond these listed, and partners may consider pursuing several smaller awards to supplement certain projects.

- [Climate Smart Communities](#): The program prioritizes funding for communities that include historically disinvested populations at increased risk to climate-related impacts. It is open to US-based project teams composed of a climate adaptation practitioner and representatives from a local or regional government entity and a community-based organization. Focus: smaller communities of up to 300,000 or 500,000 for a regional collaboration.
- [The Cameron Foundation](#): serving nonprofit organizations and government agencies in the Tri-Cities of Colonial Heights, Hopewell, and Petersburg and surrounding counties. Supports conservation, including open space preservation, planned management of natural resources, and protection of environmental quality.
- [The Campbell Foundation](#): accepts unsolicited proposals on the following areas: Agriculture, Community Engagement, and Watershed Advocacy. They primarily serve the Chesapeake Bay watershed (though they characterize this as PA, mostly) and California, and nonprofits and government agencies or schools are still eligible to apply.
- [The Chesapeake Bay Trust](#): Promotes public awareness and participation in the restoration and protection of the water quality and aquatic and land resources of the Chesapeake Bay region and other aquatic and land resources in the following categories: watershed and habitat restoration; outreach and engagement; environmental education; environmental justice; rebates for individual stormwater solutions; science; conservation and climate corps; and, capacity building.
- [Dominion Energy Charitable Foundation](#): awards grants to nonprofit organizations and public and private K-12 schools to support programs that educate students and the public about environmental science, protect and preserve natural habitats, improve open spaces and make nature accessible.
- [Renewable Natural Resources Foundation](#) (RNRF): Invites proposals for a grant opportunity aimed at fostering multidisciplinary, multisector collaborations supporting renewable natural resources. This grant is designed to support projects that incorporate evidenced-based research into real-life applications.
- [Mary Morton Parsons Foundation](#): Provides matching and challenge grants for capital projects that support Environment and Ecology, Arts and Culture, and Civic and Community Needs, among other focus areas, in Central Virginia.

- [Oak Hill Fund](#): Seeks to educate decision-makers and the public on how renewable energy and energy-efficiency can reduce carbon emissions; to install renewable energy systems in low-to-middle-income single or multi-family housing or non-profit-owned facilities; to make renewable energy installations and energy-efficient upgrades more accessible and affordable; and to protect against fossil fuel and nuclear energy development.
- [The Robert G. Cabell, III and Maude Morgan Cabell Foundation](#): Provides gifts and challenge grants to nonprofits working in Richmond on watershed protection and preservation, reclamation projects, wildlife protection, and environmental outreach and education.
- [Bunge North America](#): Bunge develops innovative solutions in agribusiness and operates a plant in Sandston. They provide general operating and project support for environmental projects in communities where they operate. A letter of request is required to learn more about their corporate investment opportunities.
- [Just Pax Fund](#): Funds organizations working on advancing economic and environmental justice.
- [Universal Leaf](#): Has partnered with Capital Region Land Conservancy, Capital Trees, Friends of the James River Park, James River Association, The Nature Conservancy, Virginia Capital Trail Foundation, and the Virginia Commonwealth University Foundation (Rice Rivers Center).

GHG Reduction Results

Based on the BAU projections and the identified measures, this plan sets a target of achieving a 22% reduction in net GHG emissions by 2035 from 2022 levels, and a long-term goal of being on a path to net zero GHG emissions by 2050. Building from the BAU analysis, the potential for GHG emission reductions from each measure was assessed, creating the Net Zero Scenario. There are multiple ways for each sector to reduce emissions; this scenario provides just one illustrative path to show potential opportunities in each sector.

Figure 4 shows the region's GHG emission projections by sector. Compared to 2022 (the inventory base year), the Net Zero pathway achieves over a 40% reduction in net emissions by 2035 and a 96% reduction in net emissions by 2050, with just 0.75 MMTCO₂e of net GHG emissions remaining in 2050. While 2050 is the long-term target, the next 10 years are critical. **The actions we take in the near-term—through 2035—offer significant potential for meaningful emissions reductions and set the foundation for deeper cuts in the decades to follow.**

This near-term focus emphasizes proven strategies and technologies that are available today, prioritizing those that are technically feasible, financially practical, and within local control or influence. Such actions are highlighted in the following section as a “near-term” action, while others are noted as “visionary” and aligned with a pathway to net zero emissions. By highlighting what we can do now, this framing illustrates a potential path to near-net zero by 2050 and builds momentum with practical actions that position the greater Richmond community for long-term success.

Figure 4: Richmond MSA GHG Emissions by Sector: Net Zero Pathway Scenario

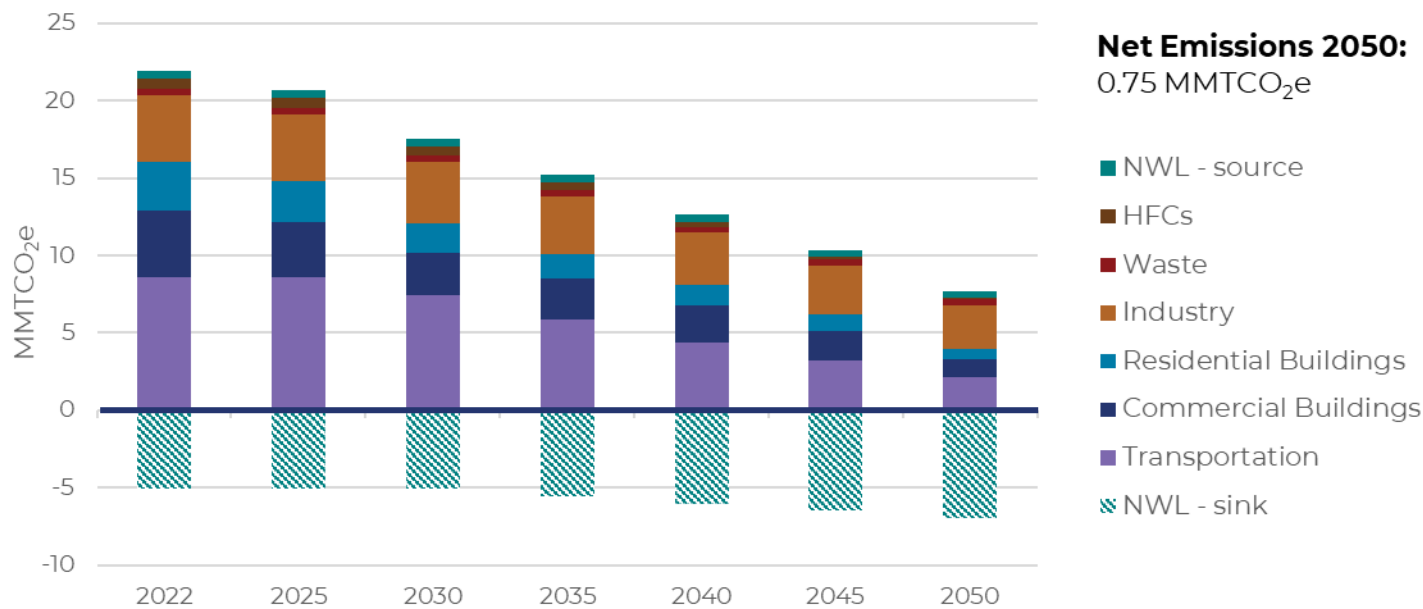


Figure 5 below presents the pathway to Net Zero Scenario via a “wedge chart”, which illustrates the impact on GHG reductions from each measure. The most impactful measures for reducing GHG emissions in this scenario include:

1. Adoption of **zero-emission vehicles**. When paired with electricity powered by clean energy (as mandated by the VCEA), this strategy results in the greatest cumulative GHG reductions in the region.
2. **Building energy efficiency and electrification** of heating, cooking, and home appliances. The region’s expected clean grid is a key enabling factor for the reductions achieved by this measure.
3. Increased sequestration protecting and restoring **wetlands** and **forest lands**.
4. The use of **low carbon fuels** like hydrogen and renewable natural gas to decarbonize fuel use in **industrial** facilities.

To present GHG reductions by measure, a “wedge chart” illustrates how different climate mitigation strategies impact GHG emissions over time. Each “wedge” represents a mitigation strategy (e.g., ZEV adoption, urban tree canopy expansion, etc.) tied to the GHG measures list in Table 2. Some measures have been aggregated to simplify the chart.

The chart shows the cumulative reductions from the various measures compared to the BAU scenario. The solid top line of the chart shows the BAU emissions, and the dashed bottom line shows the emissions under the Net Zero Scenario. The wedges in between these lines represent the GHG reductions required to close the gap between the BAU and Net Zero Scenarios. The bigger the wedge, the bigger the impact of that measure.

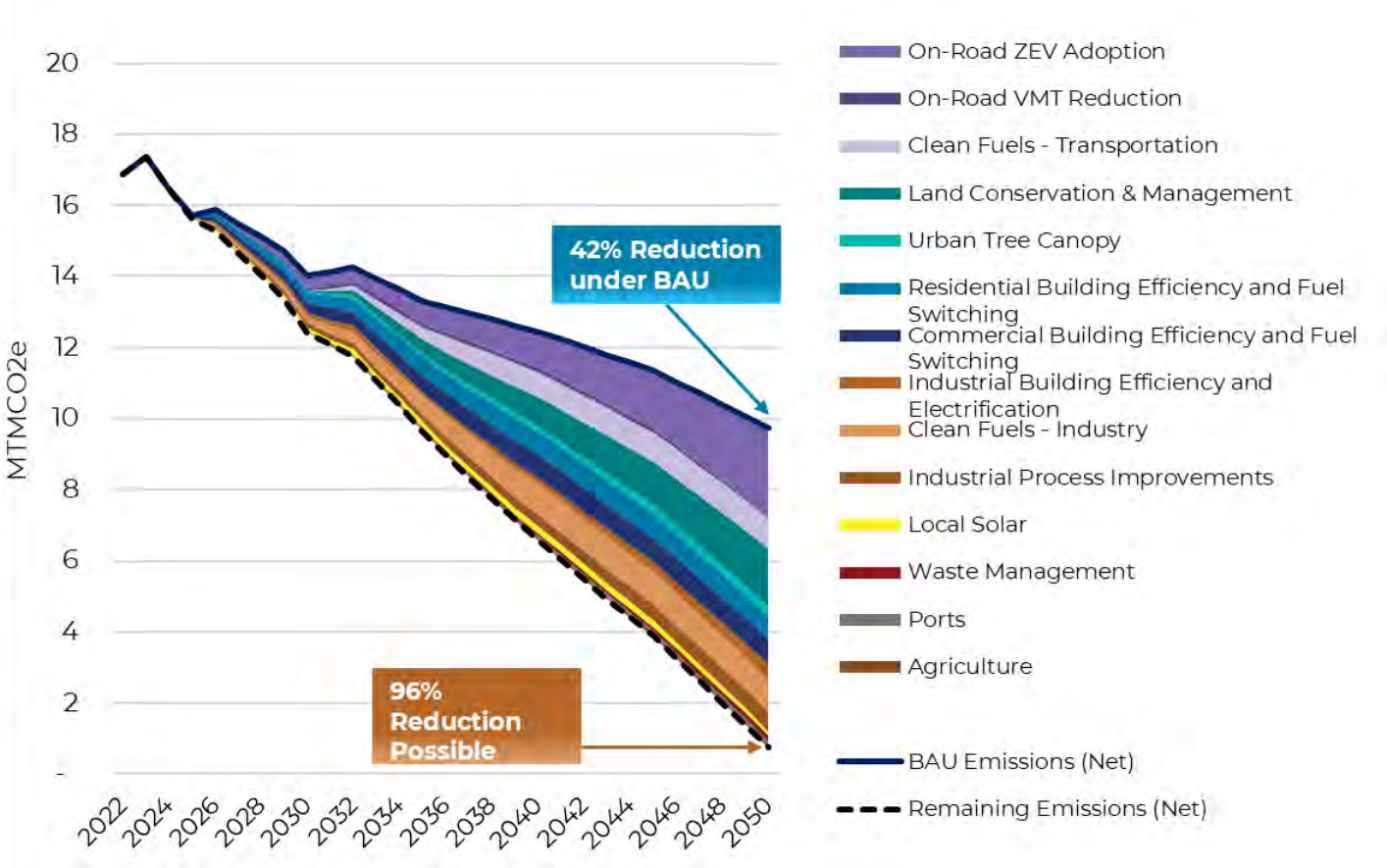
Taken together, the wedges are a visual tool to help understand how multiple measures come together to achieve the plan’s goal of net zero GHG emissions by 2050. In order of magnitude, the sectors with the greatest potential for emissions reductions are:

1. Transportation
2. Buildings
3. NWL
4. Industry
5. Waste

The state’s target for net zero electric power generation (VCEA) is key to supporting electrification across the transportation, buildings, and industrial sectors without shifting emissions from those sectors to the power sector. As the grid continues to add clean energy generation and reduce reliance on fossil fuels, emissions in

all sectors will improve. The degree to which these state goals are achieved will impact the potential reductions possible at the local level. State and regional plans are mutually reinforcing.

Figure 5: Net Zero Scenario: GHG Emission Reductions from Each Measure



Guide to the GHG measure templates

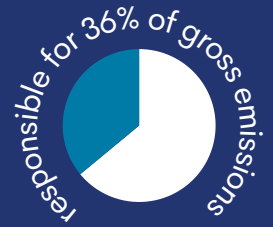
The following sections present information for each GHG reduction measure, including:

- **Sector overview:** Summary of the sector's main sources of emissions, relevant measures, and implementation partners.
- **Measure name and description:** Summary of the purpose of the measure and actions.
- **Co-benefit icons:** In the banner below the measure name, icons indicate applicable co-benefits. Indicators include improved health outcomes, improved air quality, improved water quality, increased resilience to climate impacts (community resilience, extreme heat, flooding, etc.), and improved habitat and biodiversity.



- **GHG Reduction Estimation:** Next to the co-benefit icons, some measures include an estimate of the how many greenhouse gas emissions could be eliminated if the measure was fully implemented. Details on how that figure was calculated can be found in Appendix B. Not all measures include a reduction estimation. This is not because the measure has no impact on GHGs, but because the impacts may be indirect or occur outside of the MSA.
- **Cost Estimation:** In the far right of the banner, some measures include 1 – 3 dollar sign icons. These indicate the relative cost of full implementation of the measure. The costs are calculated differently for each measure and details can be found in Appendix B.
 - Some measures include muted dollar sign icons, which represent measures where costs were not quantified as part of this report, but may be incurred during implementation of the actions.
- **Key Actions:** Specific steps and project examples to implement the measure. Actions are a menu of options for implementers to consider going forward. Actions are designated as either near-term or visionary. Near-term actions utilize proven strategies and technologies that are available today, financially practical, and within local control or influence. Near-term actions will help achieve the plan's 2035 goal. Visionary actions are those that will help the region achieve net zero emissions and may require significant investment or the use of emerging technologies.
- **Key Actors:** Types of entities that may have a role in measure implementation.
- **Potential Output Metrics:** Sample metrics that could be used to monitor progress over time. Not all suggested metrics may have data available today, and may be preferable by different partners. These metrics are intended to be possibilities, not recommendations. Some suggested metrics may not be feasible to collect. Implementing entities may choose metrics including, but not limited to, those listed in this report.

BUILDINGS EMISSIONS OVERVIEW



What are the main sources of buildings emissions in Richmond?



RESIDENTIAL BUILDINGS

Responsible for **42%** of building emissions



COMMERCIAL BUILDINGS

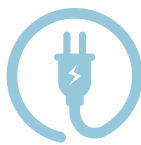
Responsible for **58%** of building emissions.

How do buildings release greenhouse gases?

Buildings emit greenhouse gases through **stationary combustion**, for example through the direct use of natural gas to power home heating systems and stove tops. These systems can accidentally emit greenhouse gases (known as **fugitive emissions**) through leaks or due to inefficiencies. The use of **hydrofluorocarbons** in refrigeration and air conditioning systems contributes to greenhouse gas emissions. Finally, buildings consume **electricity** from the grid, the generation of which releases greenhouse gases.



STATIONARY COMBUSTION



ELECTRICITY



HYDROFLUORO- CARBONS (HFCs)



FUTIGIVE EMISSIONS

How can local players support building decarbonization?



LOCAL GOVERNMENT

Through zoning and benchmarking programs.



BUILDERS & CONTRACTORS

Through procurement and construction practices.

BUILDINGS

MEASURES & PARTNERS

HOW DOES RICHMOND PLAN TO REDUCE EMISSIONS?



Invest in energy efficiency, electrification, and other improvements to achieve net zero operations for **municipal and school buildings**.



Increase resident education and awareness of utility, state, and federal incentives for energy efficiency **home improvements and electric appliances**.



Increase energy efficiency in existing **commercial and industrial buildings** through financial incentives and educational outreach programs.



Strongly encourage the design, building, and operation of residential, commercial, and industrial buildings **above current required code**.

BUILDINGS SECTOR PARTNERS



Virginia Department of Environmental Quality administers the Home Electrification and Appliance Rebates (HEAR) program.



Virginia Energy collaborates with the Governor's office to develop comprehensive energy plans.



Department of Housing and Community Development administers the Uniform Statewide Building Code (USBC), including energy codes for residential and commercial buildings. They also administer the Weatherization Assistance Program (WAP).

B1. Invest in energy efficiency, electrification, and other improvements to achieve net zero operations for municipal and school buildings.



2025-2050 GHG Reductions: 3 MMTCO₂e



This measure provides technical and financial assistance to help municipal and school buildings reduce emissions and save money through energy efficiency, electrification, and other clean energy investments. By leading by example with high-performance standards, retrofitting facilities with renewable energy and efficient technologies, and supporting comprehensive building energy management, local governments can reduce GHG emissions, lower utility costs, and improve indoor environments. The measure also strengthens community engagement, expands access to resources and incentives, and encourages broader adoption of sustainable practices across public and private sectors. This measure is most appropriate for localities and school districts.

Measure Goals and Outcomes

Category	Outcome
Energy and Cost Savings	Reduced energy use and associated costs
GHG Emissions	Lower GHG emissions from building operations
Indoor Environment	Improved indoor air quality and thermal comfort

Key Actions

Lead by example in facility efficiency and electrification to encourage residential and commercial building owners to make upgrades to their buildings:

- **NEAR-TERM** Meet statewide High-Performance Buildings Act requirements to ensure new and renovated public buildings meet efficiency requirements. Ensure all new government buildings meet Leadership in Energy and Environmental Design (LEED) standards or similar (e.g., Living Building, Earthcraft, etc.), following the successful implementations in Henrico and Chesterfield Counties. **Key Actors:** Localities
- **VISIONARY** Develop building energy performance standards and best practices for all public facilities. Track energy and emissions to inform project selection to cost-effectively reduce emissions. **Key Actors:** Localities

Enhance Public Facilities:

- **NEAR-TERM** Retrofit public buildings with solar panels and EV charging stations, prioritizing more affordable on-site solar installations that do not trigger expensive grid upgrade requirements. **Key Actors:** Localities
- **NEAR-TERM** Audit existing public buildings to identify potential efficiency upgrades **Key Actors:** Localities,

- **NEAR-TERM** Transition to LEDs and eventually solar-powered lights in streetlights, government facilities, and schools. Install motion-sensors on lighting, inside and outdoors wherever possible. **Key Actors:** Localities
- **VISIONARY** Include considerations for embodied carbon when designing new municipal or school facilities. **Key Actors:** Localities

Improve community engagement and regulatory capacity:

- **NEAR-TERM** Improve information sharing to ensure local governments are aware of resources available. **Key Actors:** Localities, regional organizations
- **NEAR-TERM** Develop or clarify zoning to allow for more EV charging facilities. **Key Actors:** Localities

Provide financial incentives:

- **NEAR-TERM** Consider [energy saving performance contracting \(ESPC\)](#) options leveraging information and resources provided by Virginia Energy¹². **Key Actors:** Localities
- **VISIONARY** Establish a revolving green fund¹³ for energy and water efficiency projects, leveraging resources like DOE's Loan Program Office and similar programs at the state level **Key Actors:** Localities

Green Buildings in Henrico

Henrico has 25 LEED-certified government and school facilities to date, and Henrico County Public Schools is developing a Living Building at [Wilton Farm](#)—the first K-12 Living Building Challenge facility in the world and one of only 30 such buildings globally. The site will feature renewable energy, an orchard, outdoor learning spaces, and more. It will serve the Varina High School Center for Environmental Studies and Sustainability.

Possible Output Metrics

Metric
Number of LEED-certified, Living Building, or other certifications for local government and school buildings
Number of buildings that are all-electric, net zero, or meet passive house standards
Number of schools and local government buildings that participated in incentive programs for building energy efficiency or electrification
Number of heat pumps and Heating, Ventilation, and Air Conditioning (HVAC) systems (either efficient gas or electric) installed
Number of projects that paired building upgrades with EV infrastructure installation or onsite solar
Number of ESPC projects, and amount of energy and dollars saved as a result

¹² <https://energy.virginia.gov/energy-efficiency/performancecontracting.shtml>

¹³ § 15.2-958.3:1. Local green banks - <https://law.lis.virginia.gov/vacode/title15.2/chapter9/section15.2-958.3:1/>

B2. Increase resident education and awareness of utility, state, and federal incentives for energy efficiency home improvements and electric appliances.



2025-2050 GHG reductions: 13 MMTCO₂e



This measure aims to empower residents to make informed decisions about energy efficiency and electrification. The goal is to help households understand their options, reduce energy use, and lower utility bills. Consumer choices can be supported by increasing education and awareness of utility, state, and federal incentives for home improvements and electric appliances, having access to cost-benefit comparisons, enrolling in community-scale aggregation programs like Solarize, and getting a home energy audit. Weatherization of older or low-income homes should be prioritized before a homeowner makes major investments in upgraded systems. Weatherization can result in immediate cost savings and improved comfort and will maximize the return on investment of more expensive upgrades made later. By making information and resources more widely available, the measure encourages broader and equitable participation in the transition to efficient, all-electric homes. This measure is most appropriate for nonprofits, private businesses, utilities, regional entities, localities, and state agencies.

Heat Pump HVAC System Costs

- Typical upfront cost: \$10,000–\$17,000 before incentives
- Incentives: up to \$8,000 in federal rebates may be available (HEAR)
- Estimated lifetime savings over 15 years: \$5,400 - \$24,200 compared to a gas furnace/central AC and electric resistance/central AC system.

These savings help offset the higher upfront price, with a typical payback period of approximately 5–10 years, for households transitioning from electric-resistance systems. See Appendix E for more info.

Measure Goals and Outcomes

Category	Outcome
Resident Awareness	Educate residents about utility, state, and federal incentives
Home Health	Improved in-home comfort and indoor air quality
Energy and Cost Savings	Reduced energy use and associated costs

Key Actions

- **NEAR -TERM** Create tools for residents to compare their existing heating and cooling systems to more efficient systems. Develop user-friendly guides to explain the options to consumers. **Key Actors:** Localities, nonprofits, regional organizations, state.

- **NEAR-TERM** Support community-scale aggregation programs, such as [Solarize](#)¹⁴, which enable a group of residents to access a bulk solar purchasing discount. **Key Actors:** Localities, nonprofits, regional entities
- **NEAR-TERM** Prioritize weatherization before installation of electrification measures. **Key Actors:** Localities, nonprofits, private businesses, regional entities
- **NEAR-TERM** Provide funding for low- to no-cost home energy audits. **Key Actors:** Localities, nonprofits, state agencies
- **NEAR-TERM** Develop and distribute user-friendly guides or toolkits explaining available incentives, eligibility, and application processes tailored for homeowners, renters, and landlords. Collaborate with state agencies, utilities, and nonprofits to avoid duplicating efforts. **Key Actors:** Localities, nonprofits, private businesses, regional entities
- **NEAR-TERM** Host in-person or virtual webinars or workshops to walk residents through the benefits of energy efficiency, electrification, and how to access incentives. **Key Actors:** Localities, nonprofits, private businesses, regional entities
- **NEAR-TERM** Establish partnerships with utilities to include energy efficiency information in monthly bills or through targeted communications. **Key Actors:** Localities

Possible Output Metrics

Metric
Number of households served by community-scale aggregation programs
Number of low- to no-cost home energy audits funded
Number of residents reached through outreach campaigns
Number of homes weatherized through local or state programs

B3. Increase energy efficiency in existing commercial and industrial buildings through financial incentives and educational outreach programs.



2025-2050 GHG reductions: 37 MMTCO₂e



This measure aims to increase energy efficiency in existing commercial¹⁵ and industrial buildings by offering financial incentives and educational outreach programs. Providing funding, technical assistance, and support for clean energy lending helps building owners, especially in underserved markets, overcome barriers to upgrading their facilities. Outreach efforts and partnerships with community organizations and utilities ensure that building owners and managers are aware of resources, best practices, and incentives, making it easier to implement energy-saving improvements and reduce emissions. **Note - the emissions from*

¹⁴ <https://cityrenewables.org/solarize/>

¹⁵ Commercial buildings include apartment buildings and public housings.

industrial buildings are included in the industry sector, not the buildings sector. This measure is most appropriate for state agencies, localities, private businesses, and nonprofits.

Measure Goals and Outcomes

Category	Outcome
Energy Use and Costs	Reduced energy use and operating costs
GHG Emissions	Lower GHG emissions
Building Comfort	Improved building comfort

Key Actions

Provide funding and technical assistance

- **NEAR-TERM** Leverage clean energy lending programs, such as C-PACE¹⁶.
- **NEAR-TERM** Promote available state and federal incentive and grant opportunities. Provide technical assistance to public entities, businesses, and individuals on how to qualify and utilize them. **Key Actors:** Localities, nonprofits, regional entities, state agencies
- **NEAR-TERM** Provide financial support or incentives for low- to no-cost energy audits for small businesses. **Key Actors:** Nonprofits, localities, state agencies
- **VISIONARY** Provide funding and technical assistance to building owners for scoping projects and combine multiple sources of funding to pay for building upgrades. Prioritize underserved markets. **Key Actors:** Localities, nonprofits, state agencies
- **VISIONARY** Research mechanisms for local businesses to cost-effectively pursue energy efficiency upgrades in their buildings and operations, including on-bill financing¹⁷ and tax incentives. **Key Actors:** Localities, state agencies
- **VISIONARY** Explore creative funding opportunities, including working with local lenders and the philanthropic community, for providing zero-interest short term loans for retrofitting and upgrading public housing. **Key Actors:** Localities, private businesses, state agencies

Energy efficiency and performance tracking programs

- **NEAR-TERM** Encourage large information technology (IT) users, such as data centers, educational institutions, and others, to adopt efficient equipment procurement processes, such as [ENERGY STAR IT equipment](#)¹⁸. **Key Actors:** Localities, private businesses, regional entities, state agencies.¹⁹
- **VISIONARY** Create a voluntary energy performance tracking and annual reporting program for commercial and large multi-family or mixed-use buildings. A recognition program for high-performing buildings could incentivize participation and promote the efforts of participating businesses to the public. **Key Actors:** Localities

¹⁶ virginiapace.com

¹⁷ On-bill financing lets customers pay for energy efficiency upgrades through installments added to their utility bill, making improvements more affordable by spreading the cost over time.

¹⁸ https://www.energystar.gov/products/data_center_equipment/5-simple-ways-avoid-energy-waste-your-data-center/institute-energy

¹⁹ For more information on available ENERGY STAR certifications for IT processes and how they can benefit large data users, see Appendix D.

- **VISIONARY** Report on the power use effectiveness (PUE) of facilities with dedicated IT infrastructure, such as higher education institutions and research facilities, data centers, and telecommunication facilities. Reporting could be incentivized through a voluntary program or required through local ordinance or state regulation. **Key Actors:** Localities, private businesses, state agencies.

Outreach and engagement

- **NEAR-TERM** Educate customers (e.g., data center operators, institutions, IT departments) on best practices for managing [servers/IT equipment](#)²⁰, which can make up a major portion of a building's energy use. Refer to Appendix D for suggested best practices. **Key Actors:** Localities, private businesses, regional entities, state agencies.
- **NEAR-TERM** Conduct outreach and educational campaigns on available incentive programs and facilitate connections between building managers and energy audit programs. **Key Actors:** Localities, nonprofits, regional entities, state agencies.
- **NEAR-TERM** Partner with community-based organizations and utilities to educate building owners, including nonprofits, places of worship, and small businesses on best practices for energy efficiency, as well as any resources and rebate programs from utilities. **Key Actors:** Localities, nonprofits, private businesses, regional entities, state agencies
- **VISIONARY** Facilitate connections between commercial and industrial building energy managers and utilities to conduct energy audits and support knowledge sharing on tangible ways to decrease energy consumption. **Key Actors:** Localities, private businesses, state agencies

C-PACE

[C-PACE \(Commercial Property Assessed Clean Energy\)](#) is a financing tool that provides 100% upfront capital to property owners who want to upgrade their buildings with energy efficiency, renewable energy, and water management systems. 6 of the MSA's localities are currently enrolled in the program: **Chesterfield, Henrico, Hopewell, Petersburg, Richmond, and Sussex.**

Possible Output Metrics

Metric
Number of residential buildings that participate in incentive programs and number of type of equipment or retrofit undertaken (e.g., weatherization or heat pump installation)
Number of communities enrolled in C-PACE and dollar value of projects funded through the program
Energy use change and GHG emissions improvements from tracked projects
Number of participants in any voluntary benchmarking programs
Number of outreach events and technical assistance materials developed and shared
Overall energy consumption and change in GHG emissions from the commercial and industrial buildings sector in the region
Number of facilities achieving ENERGY STAR Certification and retaining it year-over-year.
Average PUE of reporting facilities

²⁰ <https://datacenters.lbl.gov/it-equipment-management>

B4. Encourage the design, construction, and operation of residential, commercial, and industrial buildings above the current required code.



2025-2050 GHG reductions: 0.6 MMTCO₂e



This measure reduces GHG emissions by encouraging the design, construction, and operation of buildings above the minimum standard required by code. By promoting advanced standards such as passive house design²¹, solar-ready construction, and energy efficiency incentives, the measure aims to significantly reduce building energy use, lower emissions, and enhance comfort and resilience. Supporting above-code development through incentives, recognition, and technical resources helps drive innovation and showcases the benefits of high-performing, sustainable buildings to the broader community. This measure is most appropriate for nonprofits, private businesses, utilities, regional entities, and localities.

Measure Goals and Outcomes

Category	Outcome
Energy Use and Cost	Reduced energy use and operating costs
GHG Emissions	Reduced GHG emissions
Indoor Air Quality	Improved ventilation, air filtration, and thermal comfort

Key Actions

- **NEAR-TERM** Incentivize solar- and EV-ready development through tax incentives. Research and promote the return on investment (ROI) of developing buildings with these standards. **Key Actors:** Localities, state agencies
- **NEAR-TERM** Incentivize density. Leverage density bonuses²² to developers for projects that are energy efficient and improve access to high quality, affordable housing. **Key Actors:** Localities
- **NEAR-TERM** Establish Green Development Zones²³ to offer incentives for qualified businesses or businesses that operate in an energy-efficient building. **Key Actors:** Localities
- **NEAR-TERM** Work with local housing authorities to increase efficiency standards for their projects.
- **NEAR-TERM** Benchmark municipal building energy data and establish voluntary benchmarking and recognition programs for privately-owned buildings. **Key Actors:** Localities, nonprofits, private business
- **NEAR-TERM** Encourage building owners to track energy usage and implement energy efficiency improvements. **Key Actors:** Localities, nonprofits, private businesses

²¹ Passive house design is an extremely high energy efficiency standard achieved through an airtight envelope, efficient use of solar, geothermal heating/cooling, and recovery heat sources. <https://www.eesi.org/articles/view/the-history-of-passive-house-a-global-movement-with-north-american-roots>

²² § 15.2-2305.1. Affordable housing dwelling unit ordinances

²³ <https://www.vedp.org/incentive/green-development-zones>

- **NEAR-TERM** Encourage implementing best practices for cooling & air management of IT equipment including:
 - Free air cooling through air economizers²⁴.
 - In-row, overhead, or rear door refrigerant-based heat exchangers.
 - Hot aisle/cold aisle arrangements when air cooling is utilized.
 - **Key Actors:** Localities, private businesses.
- **NEAR-TERM** Encourage onsite energy efficiency improvements of water-cooling systems, including:
 - Raising the chilled water temperature to be only as cold, as necessary.
 - Evaluating chillers for upgrades and replacements.
 - Utilizing monitoring systems for real-time management and efficiency.
 - Reviewing operation and efficiency on a regular basis and conducting regular staff training.
 - During site selection and design, evaluate opportunities to use recycled wastewater and closed-loop cooling systems to minimize impacts on public water supplies.
 - **Key Actors:** Localities, private businesses.
- **NEAR-TERM** Implement best practices for power infrastructure and uninterruptible power supplies (UPS). **Key Actors:** Localities, private businesses, state agencies
- **VISIONARY** Emphasize passive house design in new construction. **Key Actors:** Localities, private businesses
- **VISIONARY** Under the authority granted by Virginia Code §58.1-3221.2, create a separate property tax class for energy-efficient buildings, including those exceeding the Virginia Uniform Statewide Building Code energy standards by 30% or that meet standards for the Green Globes, LEED, EarthCraft House Program, or federal ENERGY STAR programs. **Key Actors:** Localities
 - Publicize high performing buildings (LEED Platinum, Living Building, etc.) to help showcase what is possible to achieve and help motivate building owners that are already high performing to continue their efforts.
 - Provide public tours of high performing buildings to help construction companies, building owners, and other entities to envision future energy efficiency changes.
 - Adopt C-PACE, if not already locally adopted, and better promote it to commercial building owners to encourage energy efficiency upgrades in the commercial sector.
- **VISIONARY** Investigate novel or creative options to encourage above-code development. **Key Actors:** Localities

Richmond Sustainable Design Standards (SDS)

The City of Richmond has gone above and beyond what is required by law by adopting Sustainable Design Standards (SDS) for city-funded projects. The SDS provide guidance on community outreach, site selection, and impact avoidance during project planning, while also setting clear standards for water use, energy efficiency, indoor environmental quality, transportation, stormwater management, landscaping, and architectural design.

²⁴ An air economizer is a component of an HVAC system that uses cool outside air to cool a building, reducing the need for mechanical cooling and saving energy. <https://svach.lbl.gov/what-is-an-economizer/>

Possible Output Metrics

Metric
Number of new buildings that participate in incentive programs and achieve certification (e.g., LEED, Living Building, or others)
Number of buildings that are all-electric, net zero, or meet passive house standards
Number of participants in any ongoing voluntary benchmarking programs
Number of outreach events and technical assistance materials developed and shared

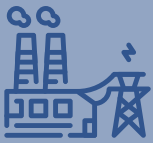


Urban gardening in Richmond. Source: Nicole Keller

ENERGY EMISSIONS OVERVIEW

What resources does Richmond use to meet its electricity demand?

Traditional energy sources



Power plants burn fuels like natural gas to produce energy in the form of steam. The steam spins a generator, which produces electricity.

Burning these fuels releases greenhouse gases, like carbon dioxide.



FOSSIL FUELS

Responsible for **66%** of energy emissions

This category includes fuels like **coal, natural gas, and oil**. Fossil fuels power 9 out of 32 power plants in the Richmond area.



BIOGENIC GASES

Responsible for **34%** of energy emissions

This category includes fuels like **methane** captured from landfills, as well as **biomass**. These fuels power 9 out of 32 power plants in the Richmond area.

Clean energy sources



Clean energy generation uses power from the sun, wind, nuclear fission, or dams to spin generators and produce electricity without releasing greenhouse gases.



SOLAR

Powers 13 out of 32 power plants in the Richmond area

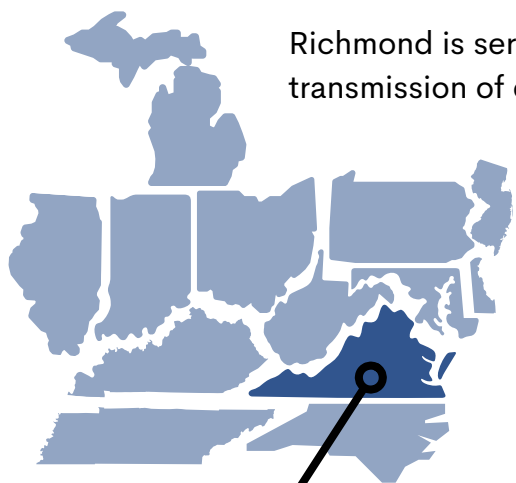


HYDRO

Powers 1 out of 32 power plants in the Richmond area

ENERGY MEASURES

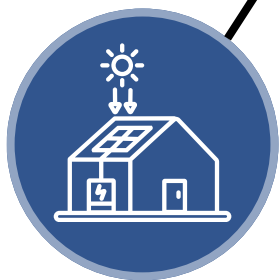
Electricity in the region and at home



Richmond is served by **PJM**, a regional organization that coordinates the transmission of electricity across 13 states and the District of Columbia.

Electricity generated in Richmond can be distributed and consumed in other parts of PJM's region. Similarly, electricity consumed in Richmond can be generated in other parts of PJM's region.

According to the U.S. Energy Information Administration, **Virginia imports more electricity than it exports.**



Clean energy makes up the majority of grid-level electricity generated in Virginia. **52% of electricity generated in the Commonwealth comes from clean energy.** Of this 52%, 35% comes from nuclear, 1% from hydropower, and 16% from other renewables like wind and solar.

Clean energy, especially solar, plays an important role **"behind the meter"** as well, generating electricity for individual homes and buildings to help homeowners and small businesses cut costs.

HOW DOES RICHMOND PLAN TO REDUCE EMISSIONS?



Support the adoption of **distributed renewable energy resources**



Support the development of **grid-scale clean energy development** and utility efforts to enhance grid resiliency.

ENERGY

IMPLEMENTATION PARTNERS

ENERGY PARTNERS



SCC regulates investor-owned utilities (IOUs) and some electric cooperatives to ensure utilities provide safe and reliable service at just and reasonable rates and require IOUs to submit integrated resource plans.



DEQ oversees environmental impacts, such as stormwater management and potential effects on wetlands and wildlife. Project developers often need to obtain permits related to these environmental aspects from the state agency.



PJM manages wholesale electricity markets, ensures grid reliability, and manages the interconnection queue for the region.



The Federal Energy Regulatory Commission regulates the transmission and wholesale sale of electricity in interstate commerce.



Dominion Energy is a key electricity provider in the Richmond MSA, a power plant developer, and is subject to VCEA requirements.

E1. Support the adoption of distributed renewable energy resources.



2025-2050 GHG reductions: 3 MMTCO₂e



Increasing the deployment of renewable energy is essential for reducing emissions and promoting energy independence. Establishing regional and locality-specific goals for solar megawatt (MW) production provides clear targets for renewable energy adoption. Streamlining the approval process for solar installations, supporting shared solar that can directly benefit communities, and encouraging the use of clean onsite backup power can help increase the deployment of clean energy distributed resources in the region. Distributed resources can minimize land use impacts compared to larger generation projects and help insulate residents from high electricity costs. The increased clean energy supply, particularly from onsite backup power generators, can improve air quality by reducing pollution from burning fossil fuels. This measure is most appropriate for localities and private businesses.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Resilience	Improved grid resilience
Cost Savings	Lower energy bill costs

Key Actions

Increase community solar adoption

- **NEAR-TERM** Adopt automatic permitting processes, such as SolarApp+. **Key Actors:** Localities
- **NEAR-TERM** Establish regional-specific goals for solar MW deployment, both distributed and utility-scale. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Pursue SolSmart designation at the local and regional levels to reduce the soft costs of solar development. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Define and implement a pathway for low-to-moderate income (LMI) residents to participate in a community solar program through program design and/or financing support options. **Key Actors:** Localities, private businesses, state agencies

Rooftop Solar System Costs

- Typical upfront cost: \$17,500–\$21,000 before incentives for a 7 kW system
 - Estimated lifetime savings over 25 years: \$10,000 - \$24,000
- A 7 kW system can generate most or all of a typical home's annual electricity needs, depending on household energy use, roof orientation, and shading. Many Virginia households experience a simple payback period of approximately 10–15 years, with continued energy bill savings over the remaining life of the system.

Actual costs and savings will vary based on roof conditions, system size, equipment selected, electricity use, and available incentives from local governments, states, or utilities. See Appendix E for more information.

- **NEAR-TERM** Support community aggregation solar programs that reduce costs for residents. **Key Actors:** Localities, nonprofits, state agencies
- **NEAR-TERM** Identify parcels for potential shared solar projects and publish Request for Information (RFIs) from solar developers to explore possible rate savings for residents. When shared solar projects are pursued, as much capacity as possible should be allocated to low-income customers. Collaborate with utilities to expand existing programs and/or develop pilot programs to adopt solar ready homes and distributed renewable energy, storage, and peak management. **Key Actors:** Localities

Reduce fossil fuel use at high energy use facilities

- **NEAR-TERM** Encourage options to reduce emissions from backup power systems, such as replacing diesel generators with natural gas generators. **Key Actors:** Localities, private businesses
- **VISIONARY** Eventually, back-up power systems should be replaced with clean energy storage solutions. Large battery storage systems to provide on-site backup power are not currently cost-effective at the scale, but in the future technology advancements could make them more attractive options.
- **VISIONARY** Deploy Combined Heat and Power (CHP) systems. Pair CHP plants with fuel cells to realize even greater efficiency. Utilize hydrogen blends and/or pure hydrogen in place of natural gas, if available. For more information on CHP systems and fuel cells, see Appendix D. **Key Actors:** Localities, private businesses
- **VISIONARY** Conduct feasibility studies for district energy. District energy systems can be considered in planning for new commercial and industrial campuses, wastewater treatment facilities, and any other source of waste heat. District energy systems carry hot water or steam through insulated pipes to provide energy or heating for nearby buildings. **Key Actors:** Localities, private businesses.

Sunny Spots: Chesterfield and Henrico

Chesterfield County and Chesterfield County Public Schools purchase clean energy for their facilities through a solar power purchase agreement (PPA) with Sun Tribe. PPAs deliver clean energy and electric rate stability with no upfront capital investment.

The Solar Access Henrico program expands access to solar by using \$5 million secured through a 2024 Varina rezoning to provide free residential solar installations for approximately 200 low-income households. More than 75 households have enrolled so far.

Possible Output Metrics

Category	Metric
Solar	Total solar megawatt capacity installed and number of solar installations
Permit Processing	Average permit processing time for solar projects
Community Solar	Number of community solar programs
LMI Participation	Participation rate of LMI households in community solar programs or with solar systems installed
Renewable Sources	Percentage of electricity from renewable sources

E2. Support the development of grid-scale clean energy development and utility efforts to enhance grid resiliency.



Enabling Action with Indirect & Statewide Benefits



This measure supports achievement of the VCEA, which is driving the state's electric grid towards a net zero emissions future. The VCEA looks to develop over 16 GW of solar and onshore wind, 5.2 GW of offshore wind, and 2.7 GW of energy storage capacity over the next decade, in addition to putting utilities on a path to net zero GHG emissions by 2050.

A key component of the VCEA is deploying clean energy resources across the state and ensuring a reliable grid. This necessitates collaboration, with localities supporting resource deployment in a sustainable manner and ensuring complementary priorities are met (e.g., promoting biodiversity alongside clean energy projects and using under-utilized land for project siting). This measure is most appropriate for state agencies, local governments, nonprofits, and regional entities.

Now, more than ever, the electric grid is facing a wave of challenges creating significant uncertainty that permeates through modeling, decision-making, and policies. These uncertainties will have a significant impact on the region's ability to successfully implement VCEA clean energy targets.²⁵ Key uncertainties include:

- **Load growth and data center dynamics:** Rapid expansion and rising energy intensity drive uncertainty in both load levels and peak demand timing. Building sector energy efficiency and managed EV charging solutions can help mitigate impacts on peak load and are critical focus areas as these sectors electrify.
- **Emerging technology and innovation** (e.g., small modular nuclear reactors, long duration battery storage): Timing and cost of deployment are uncertain, depending on technology development, regulatory approval, supply chain readiness, and investment from utilities or private developers.
- **Resource availability and cost:** Supply chain volatility, interconnection costs, and fuel cost drive uncertainties for the costs of new energy resources.
- **Transmission system infrastructure:** Congestion and limited transfer capacity within Pennsylvania-New Jersey-Maryland Interconnection (PJM) may delay siting and lean energy projects. Long lead times for permitting and development of new transmission infrastructure pose a risk to achieving VCEA renewable energy targets.
- **VCEA implementation:** The VCEA applies only to investor-owned utilities; private entities such as data centers can develop their own on-site fossil fuel generation. The VCEA also includes a reliability exception, under which utilities can petition the SCC for relief from VCEA targets if they can demonstrate a reliability or security threat. The purpose of this is to maximize the state's energy reliability and resilience and ensure an adequate energy supply during the transition to renewable energy sources. The broader grid and

²⁵ The [Dominion Energy 2025 Update to the 2024 Integrated Resource Plan \(2025 IRP update\)](#) evaluated multiple portfolios that incorporate VCEA requirements. Dominion highlights the challenges of complying with VCEA's net zero GHG target (\$10.1-1308 E) while incorporating assumptions related to reasonable capacity deployment levels, affordability concerns, and reliability concerns.

resource interconnection concerns, in addition to the cost to site and build new resources are key factors that will determine the successful implementation of the VCEA targets.

Nonetheless, solar is the fastest and cheapest source that can be added to the grid today, and comes with the fewest adverse impacts, compared to other types of power sources. The Virginia CPRG Plan contains more information on how the state plans to address energy reliability and GHG reduction goals.

Measure Goals and Outcomes

Category	Outcome
Resilience	Increased grid resilience and reliability
Land Use Optimization	Utilization of otherwise unusable land

Key Actions

- **NEAR-TERM** Advocate for the [Pollinator Smart](#)²⁶ standards for solar projects to be required at the state level. Incorporate adherence to Pollinator Smart practices into local solar ordinances. **Key Actors:** Localities, nonprofits, state agencies
- **NEAR-TERM** Advocate for state-level policies that support clean energy development and adoption while preserving local autonomy. Support measures that enable local governments to require on-site solar integration in new projects, where they wish, such as on parking lots or new commercial buildings. **Key Actors:** Localities, nonprofits
- **NEAR-TERM** Streamline permitting and zoning for grid-scale renewable energy deployment. Clear and simple permitting processes saves money, time, and effort without sacrificing local control. **Key Actors:** Localities
- **NEAR-TERM** Advocate for the continued support of full implementation of the VCEA. **Key Actors:** Nonprofits
- **NEAR-TERM** Explore Power Purchasing Agreements (PPAs) for municipal energy needs. **Key Actors:** Localities
- **VISIONARY** Prioritize solar redevelopment on brownfields, such as closed landfills. **Key Actors:** Nonprofits, state agencies
- **VISIONARY** Study geothermal potential in the region. **Key Actors:** Private businesses, state agencies
- **VISIONARY** Improve and accelerate the interconnection process for distributed energy resources (DERs). **Key Actors:** State agencies
- **VISIONARY** Evaluate the potential for district energy systems to recycle waste heat from data centers or wastewater treatment facilities. **Key Actors:** Localities, private businesses

East End Solar Meadow

In the east end of Richmond, an old landfill is poised to become a new source of clean energy. The City plans to develop the capped landfill site into a [14.5 acre solar farm](#) that would generate 5MW of energy – enough to power 500 homes. The solar farm will feature a pollinator meadow and a \$500,000 Community Benefits Agreement earmarked for projects in the 7th District.

²⁶ <https://www.deq.virginia.gov/air-energy/renewable-energy/virginia-pollinator-smart-program>

Possible Output Metrics

Metric
Megawatts of installed grid-scale clean resources in the MSA
State-wide grid carbon intensity

INDUSTRY EMISSIONS OVERVIEW



What are the main sources of industrial emissions in Richmond?



STATIONARY COMBUSTION & ELECTRICITY USE

Responsible for **71%** of buildings emissions

Stationary combustion is the direct use of natural gas to power industrial buildings.



INDUSTRIAL PROCESSES & PRODUCT USE (IPPU)

Responsible for **22%** of industrial emissions

IPPU includes activities that physically or chemically transform materials, such as steel production.



FUGITIVE EMISSIONS

Responsible for **2%** of industrial emissions

Fugitive emissions are unintentional emissions, released due to leaks or equipment malfunctions.



HYDROFLUORO- CARBONS (HFCs)

Responsible for **5%** of industrial emissions.

HFCs are synthetic chemicals widely used as refrigerants and in air conditioning systems. They are potent greenhouse gases.

Spotlight on HFCs



HFCs were first introduced to replace chlorofluorocarbons (CFCs), which were commonly used as refrigerants and found to damage the ozone layer. The **Montreal Protocol** phased out these chemicals in the late 1980s, and in 2016, some countries committed to phasing out HFCs as well.

INDUSTRY MEASURES & PARTNERS

WHAT ARE INDUSTRY'S MAIN SUB-SECTORS?



AMMONIA



IRON & STEEL



PULP & PAPER

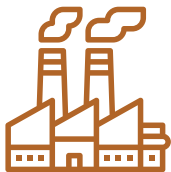


CONSUMER SAFETY
PRODUCTS

HOW DOES RICHMOND PLAN TO REDUCE EMISSIONS?



Support local production and use of low-embodied carbon materials through **clean procurement frameworks**.



Support emissions reductions from **industrial processes**.

INDUSTRY SECTOR PARTNERS



Virginia Energy collaborates with the Governor's office to develop comprehensive energy plans, such as the Virginia Energy Plan, which outlines strategies for achieving a reliable, sustainable, and affordable energy future for all Virginians.



DEQ regulates industrial emissions and can provide technical assistance for the sector.

11. Adopt clean procurement frameworks.



Enabling Action with Indirect & Statewide Benefits



Clean procurement frameworks set clear standards for public and private projects. Setting such standards helps drive demand for sustainable alternatives and fosters innovation in the building sector. Procurement standards require better reporting and documentation, increasing awareness and accountability for the carbon impacts of materials used. Clean procurement frameworks prioritize building materials with lower carbon footprints. Encouraging the use of locally sourced products such as recycled materials, timber, and low-carbon concretes²⁷ reduces emissions. While this measure doesn't directly reduce local emissions because these materials are not produced within the MSA, adoption of this policy does reduce emissions elsewhere, which indirectly benefits the MSA by mitigating climate change. This measure not only cuts lifecycle emissions from construction but also supports local economies and advances environmental stewardship by promoting healthier, resource-efficient materials. This measure has no cost estimation associated with it because, while there may be cost difference between low-carbon and traditional materials, there is no cost to the clean procurement framework itself. Prices of materials are constantly in flux, and with time, the difference between low-carbon and traditional materials may wane. This measure is most appropriate for localities and private businesses.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced upstream GHG emissions
Supply Chain Transparency	Better reporting and documentation
Market Transformation	Broader adoption of sustainable materials

Key Actions

- **NEAR-TERM** Adopt environmentally preferable purchasing (EPP) policies. Implement procurement guidelines that prioritize products and materials with verified low-embodied carbon content, building on best practices highlighted by the VDEQ. **Key Actors:** Local governments; private businesses, regional entities, state agencies.
- **NEAR-TERM** Leverage local supplier networks by encouraging locality agencies and contractors to source building materials from local manufacturers and suppliers, reducing transportation emissions and supporting the regional economy. **Key Actors:** Localities
- **NEAR-TERM** Set clear procurement standards. Establish minimum requirements or incentives for low-embodied carbon materials in locality-funded construction and renovation projects, referencing standards

²⁷ Low-carbon concrete has a lower carbon footprint than traditional concrete. Carbon emissions from production are reduced either by replacing some amount of cement content with other mineral compounds (such as by-products from other industrial processes), utilizing carbon capture technology to capture emissions from concrete production, or by using fossil fuel alternatives to power the production process. See the definition for 'embodied carbon.'

such as Environmental Product Declarations (EPDs) or third-party certifications. **Key Actors:** Private businesses, Localities

- **NEAR-TERM** Involve community members, local businesses, and industry experts in developing and refining procurement frameworks to ensure they are practical, equitable, and effective. **Key Actors:** Localities, private businesses, state agencies
- **VISIONARY** Launch pilot projects in municipal buildings or public works that showcase the use of innovative, low-carbon materials, providing case studies for broader adoption. **Key Actors:** Localities
- **VISIONARY** Offer training and resources to local businesses on how to certify, document, and market their low-embodied carbon products to participate in locality procurement opportunities. **Key Actors:** Localities, nonprofits, private businesses, regional entities, state agencies

Possible Output Metrics

Metric
Percentage of projects using low-carbon materials
Number of local suppliers certified
Adherence to procurement standards
Share of materials sourced from within the region

12. Support emissions reductions from industrial processes.



2025-2050 GHG reductions: 7 MMTCO₂e



The industrial sector includes activities such as the processing and manufacturing of physical and chemical materials and is a difficult sector to decarbonize. Industry in the Richmond region includes steel manufacturing, paper products, ammonia and other chemical products, pharmaceuticals, asphalt, stone quarries, and more. Most emissions in this sector result from the combustion of fossil fuels to power processes. Emissions from industrial processes can be difficult to reduce, especially when they result from chemical processes that are unavoidable without altering the underlying reaction. This measure reflects current technological and policy trends to reduce industrial emissions, including improving process efficiency and fuel switching. This measure is most appropriate for private businesses, localities, and regional entities.

While industrial processes vary significantly across industrial operations, nearly all have opportunities to enhance their thermal or electrical efficiency. In addition to efficiency, this measure seeks to decarbonize industrial operations through the electrification of low and medium temperature processes. High temperature processes are more challenging to electrify. Emissions also come from chemical processes, which may not be able to be altered. Future scientific advancements may find more efficient processes. Nationally, these areas have been a focus for research and pilot development by federal agencies such as the DOE and EPA.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Significant GHG reductions
Clean Air and Water	Achieve cleaner local air and water

Key Actions

- **NEAR-TERM** Develop clear regional priorities for continued growth in local manufacturing while prioritizing emissions reductions. Encourage companies to innovate and pilot new ideas in the region. Convene engagement sessions with industrial stakeholders and local communities. **Key Actors:** Localities, private businesses, regional entities
- **VISIONARY** Identify areas for multi-use infrastructure, such as integrating industrial hydrogen production with nearby vehicle fueling infrastructure along a trucking corridor (i.e., I-95). Coordinate with local governments and hydrogen developers in other regions of the state to connect markets and alternative fueling networks, thereby maximizing the impact of this and related Measures across the state. This action is also relevant to the transportation sector. **Key Actors:** Localities, private businesses, regional entities
- **VISIONARY** Assess the need for supporting infrastructure (e.g., pipelines or new transmission) and identify funding opportunities to support key studies (e.g., local geologic sequestration potential). **Key Actors:** Localities, private businesses, regional entities, state agencies
- **VISIONARY** Develop multi-use infrastructure for industrial hydrogen, working with potential off-takers in the region. Industrial hubs, such as those in Southside Richmond and Chesterfield, Tri-Cities, and Sussex represent opportunities to deliver electricity generation from alternative fuels to multiple customers. **Key Actors:** Localities, private businesses

Independence Hydrogen

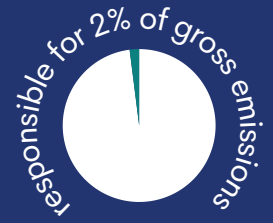
Virginia's first green hydrogen plant opened this year in **Petersburg**. The veteran-owned and operated plant takes waste gas from an adjacent bleach plant and purifies it into green hydrogen fuel. The hydrogen is primarily sold to Walmart, which uses it to fuel their zero-emission forklifts at a nearby warehouse. The project is a great example of the circular economy at work!

Possible Output Metrics

While these metrics would help track changes in energy, emissions, and project implementation over time, the data collection and reporting processes may not currently be in place to support these metrics.

Metric
GHG and other pollutants emission reductions
Amount of energy savings from efficiency projects
Number of pilot projects in the region for innovative low-carbon solutions, such as the use of hydrogen

NATURAL & WORKING LANDS EMISSIONS OVERVIEW



What are greenhouse gas sources and sinks?

Sources are processes and systems that *release* carbon dioxide and other greenhouse gases into the atmosphere. Sinks are processes and systems that *sequester and store* carbon dioxide and other greenhouse gases.

Richmond's main **greenhouse gas sources** in this sector are:



LIVESTOCK

Responsible for **49%** of agricultural emissions



AGRICULTURAL SOILS

Responsible for **37%** of agricultural emissions

Emissions from livestock mostly come from **enteric fermentation**, the process by which the digestive system breaks down food. The primary byproduct of this process is methane, a potent greenhouse gas. Preparing agricultural soils can also produce emissions, as carbon dioxide stored in soils is released into the atmosphere through **tilling**.

Richmond's main **greenhouse gas sink**:



FORESTS & URBAN TREES

Responsible for offsetting approximately **5.3 million metric tons** of carbon dioxide yearly, equivalent to **23% of gross emissions**.

5.3 million metric tons of carbon dioxide is equivalent to



1 million passenger cars powered for 1 year



or 700,000 homes powered for 1 year

NATURAL & WORKING LANDS MEASURES

WHAT ARE AGRICULTURE AND FORESTRY'S MAIN SUBSECTORS?



Forestry & Timber Management



Urban Agriculture



Livestock & Crop Production



Land Use Management



Agricultural Markets & Infrastructure



Local Food Markets

HOW DOES RICHMOND PLAN TO REDUCE EMISSIONS?



Remove carbon through **nature-based solutions**, including preserving existing natural working lands and proactively managing land use changes.



Support and incentivize shared land use with renewable energy and agricultural activities (such as **agrivoltaics**).



Expand **urban agriculture** (school/community gardens) and develop region-wide and inter-regional food system distribution.



Increase equitable **tree canopy coverage** and access to public green spaces.



Increase **soil conservation and nutrient management** in agriculture.

NATURAL & WORKING LANDS IMPLEMENTATION PARTNERS

NATURAL & WORKING LANDS PARTNERS



DEQ provides programming, funding opportunities, and technical assistance in conservation and maintenance of natural and working lands.

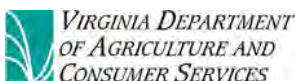


DOF provides programming, funding opportunities, and technical assistance for forest conservation.



DCR provides programming, funding opportunities, and technical assistance in conservation and maintenance for Virginia's state parks and natural area preserves.

FOOD SYSTEMS PARTNERS



VDACS provides financial and technical assistance for farmers to implement agrivoltaics and other sustainable practices.



VCE provides technical assistance, education, and resources to support urban agriculture and local food production. Offer programs and workshops for farmers and communities.

SOIL CONSERVATION PARTNERS



SWCD promotes soil erosion control measures and provides educational resources for agricultural producers to enhance soil health and increase carbon sequestration across the region.



NRCS provides additional funding and technical assistance for soil conservation initiatives, promoting long-term sustainability of working lands.

NWL1. Remove carbon through nature-based solutions, land preservation, and climate-smart land use planning.



2025-2050 GHG increased sequestration:
17 MMTCO₂e

\$\$

This measure uses land use conservation strategies to remove carbon and support ecological health. It encourages the adoption of sustainable land management practices, the integration of nature-based solutions, and the protection and restoration of natural areas. Enhancing green infrastructure, supporting healthy forests and habitats, and promoting responsible land stewardship increase carbon sequestration. These actions also improve environmental health and build long-term resilience for communities and natural systems. This measure is most appropriate for localities, nonprofits, and state agencies.

Measure Goals and Outcomes

Category	Outcome
Carbon Sequestration	Increased CO ₂ uptake from managed land area
Stormwater Reduction	Less runoff from facilities with green infrastructure
Wildlife Mobility	Increased biodiversity & wildlife movement in corridors
Water Quality	Improved water quality via riparian buffers & nutrient reduction

Key Actions

Land Use and Planning

- **NEAR-TERM** Install green infrastructure projects at public facilities and municipally owned properties, such as libraries, government buildings, right-of-way, parks and recreation facilities, and schools. **Key Actors:** Localities

Forest Management and Habitat Conservation

- **NEAR-TERM** Conserve core habitats and minimize habitat fragmentation to reduce edge effects and support biodiversity. **Key Actors:** Localities, nonprofits, state agencies

Land Conservation in Henrico

To date, Henrico has conserved more than 15,800 acres of land in the eastern half of the county and has invested more than \$30M for conservation. The County continues to identify additional opportunities to enhance conservation, such as through establishing wetland banks.

Green Infrastructure at Richmond Libraries

The James River Association, in partnership with Richmond Public Library and the city's Department of Public Utilities, has implemented green infrastructure projects at multiple library branches. These projects include the installation of bioretention basins, trees, and shrubs to manage stormwater runoff.

- **NEAR-TERM** Enhance connectivity to mitigate habitat fragmentation by conserving and restoring landscape corridors, ensuring that ecological cores remain connected to support biodiversity and ecosystem resilience. **Key Actors:** Localities, nonprofits, state agencies
 - Prioritize protections of the identified large ecological cores by Virginia Natural Landscape Assessment's (VaNLA) geospatial analysis.
- **NEAR-TERM** Advocate for the continued support of the DCR Agricultural Incentives Program and other state funding for buffer creation, support, and precision nutrient application. **Key Actors:** Localities, nonprofits, regional entities, state agencies,
- **NEAR-TERM** Promote agricultural and forestry district programs in localities to support sustainable land use practices. **Key Actors:** Localities.
- **VISIONARY** Install wildlife corridors to preserve habitat connectivity, increase green space, and improve safety. **Key Actors:** Localities, regional entities, state agencies
 - The Virginia Department of Wildlife Resources (DWR) Wildlife Corridor Action Plan (WCAP) emphasizes the protection of vital wildlife habitat corridors and the reduction of wildlife-vehicle conflicts. This plan identifies key areas for habitat connectivity, which can guide local efforts in the Richmond MSA to establish and maintain wildlife corridors.



Winston Road Farm is located in Hanover, VA.
Source: PlanRVA

Possible Output Metrics

Metric
Number of public facilities retrofitted with green infrastructure
Acreage of land protected or restored for wildlife movement
Number of projects aligned with the DWR WCAP
Acres of core habitat conserved (VaNLA-based)
Number of localities implementing ag/forestry district programs
Amount of funding secured/distributed via DCR Ag Incentives Program
Acreage of Riparian Protection Areas established or improved

NWL2. Support and incentivize shared land use with renewable energy and agricultural activities.



2025-2050 GHG reductions: 0.4 MMTCO₂e



This measure aims to accelerate the adoption of agrivoltaics — the dual use of land for both agriculture and solar energy production — by addressing regulatory, land use, and educational barriers. The measure supports sustainable land management, renewable energy generation, and resilient food production systems within the region. It is most appropriate for private businesses, localities, and state agencies.

Measure Goals and Outcomes

Category	Outcome
Renewable energy	Reduce GHG emissions from power generation by installing renewable energy
Protect crops	Protect crops from extreme heat stress by shading from solar panels, improving moisture retention

Key Actions

Land Use and Development

- **NEAR-TERM** Clarify zoning practices for agrivoltaics to reduce barriers for farmers while ensuring the protection of agricultural land. **Key Actors:** Localities
- **NEAR-TERM** Integrate Pollinator Smart practices in solar energy projects to enhance biodiversity and support ecosystem health. **Key Actors:** Localities, private businesses
- **VISIONARY** Work with Dominion to discuss multi-use opportunities for land under or parallel to utility rights-of-way. **Key Actors:** Localities, private businesses, utilities

Farmer Education & Implementation

- **NEAR-TERM** Establish demonstration agrivoltaics projects within the MSA. Organize guided site tours for local producers and decision makers. **Key Actors:** Localities, nonprofits, private businesses,
- **NEAR-TERM** Work with Soil and Water Conservation Districts (SWCDs) to share information about agrivoltaic options and any available grant or financing sources. **Key Actors:** Localities, nonprofits, regional entities, state agencies

Agrivoltaics in Charles City

Completed in 2022, the [Skipjack solar farm](#) produces 175MW of clean, renewable energy and was developed with a Community Benefits Agreement that supported local schools. It is a farm in two senses – harvesting energy from the sun and supporting sheep herds from James River Grazing! Co-locating solar and sheep reduces maintenance costs and supports a healthier ecosystem.

[James River Grazing](#) is a prescribed grazing contractor serving the solar sites. Founded by a first-generation Virginia farmer, JRG manages 2000 acres of solar in the state with a focus on caring for the land, the livestock, and our natural resources.

- **VISIONARY** Promote agrivoltaics to vineyards and hay producers in the MSA and establish demonstration projects. **Key Actors:** private businesses, regional entities

Possible Output Metrics

Metric
Number of municipalities updating zoning codes to accommodate agrivoltaic projects
Number of demonstration agrivoltaic projects established
Acreage of land under agrivoltaic use
Number of farmers receiving agrivoltaic education or technical assistance
Number of pollinator-friendly solar projects implemented
Number of partnerships established with Dominion Energy and other utility companies for multi-use right of way projects

NWL3. Expand urban agriculture and develop region-wide and inter-regional food system distribution.



Enabling Action with Indirect & Statewide Benefits



This measure focuses on strengthening local and regional food systems by promoting sustainable urban agriculture and improving food distribution networks. This supports economic development, enhances access to fresh and healthy food, and encourages the preservation and productive use of urban land. By fostering collaboration among communities, institutions, and local governments, the measure aims to build a resilient and equitable food system that benefits both urban and rural areas throughout the region. This measure is most appropriate for localities, nonprofits, and regional entities.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions by decreasing the need for long-distance food transportation
Economic Development	Strengthen local and regional food systems, developing the local economy
Food Access	Improve access to healthy food

Key Actions

Agricultural & Economic Development

- **NEAR-TERM** Conduct an agriculture/forestry economic study to analyze how local spending is allocated to different aspects of urban tree care and urban agriculture, identifying areas with high ROI for local spending. **Key Actors:** Localities, nonprofits, regional entities

- **NEAR-TERM** Support the National Urban Agriculture Initiative in the Richmond MSA. Collaborate with the Small Farm Outreach Program and Virginia Tech’s partnership with Virginia State University to advance urban agriculture and sustainable food systems in the region²⁸. This initiative aims to build connections between the USDA and urban farmers, offering project evaluation, training, and support to strengthen local food systems and enhance the capacity of urban agriculture in the Richmond MSA. **Key Actors:** Localities, nonprofits, regional entities

Land Use and Preservation

- **NEAR-TERM** Support agriculture community land trusts to preserve agricultural land and make it accessible to small or new farmers. **Key Actors:** Localities, nonprofits
- **NEAR-TERM** Preserve urban agricultural space by exploring the reuse of locality-owned parcels for urban agriculture. Leverage Virginia Tech’s Center for Sustainable Food Systems’ urban agriculture initiative. Collaborate with local municipalities to explore the reuse of vacant or underutilized city-owned parcels for urban farming. This effort aims to enhance local food access, promote sustainable agriculture, and support community-driven agricultural projects. **Key Actors:** Localities, nonprofits, regional entities



Rockwood Community Garden in Chesterfield, VA reopened April 1st, 2025 (Chesterfield Reopens Renovated Community Garden Plots at Rockwood Park, 2025). Source: Plan RVA

Richmond 100-Year Food Commons

The City of Richmond is developing a pathway towards a flourishing food commons that ensures all members of the community have access to fresh, healthy foods. A *food common* treats food and the resources needed to produce and share it—such as land, water, and knowledge—as collectively governed rather than privately owned commodities. Through practices like community gardens, food forests, and shared fridges, residents reclaim and manage urban spaces for shared access, care, and decision-making.

Possible Output Metrics

Metric
Number of schools with on-site garden
Number of Farm-to-School meal programs
Volume of locally sourced food integrated into school meals
Number of community gardens
Number of farmers markets

²⁸ <https://news.vt.edu/articles/2024/02/cals-urban-agriculture.html>

NWL4. Increase equitable tree canopy coverage and access to public green spaces.



2025-2050 GHG increased sequestration: 3 MMTCO₂e



This measure aims to expand and protect urban tree canopy across the region by setting clear canopy targets, prioritizing tree planting in areas with limited coverage, and supporting tree preservation and maintenance efforts. As communities work to expand tree cover and green spaces, plant species should be chosen with care, prioritizing native and climate-resilient species, appropriate placement, and removal of invasive species where necessary to support healthy ecosystems. By working with local governments, nonprofits, and community groups, the measure seeks to enhance climate resilience, reduce urban heat, improve air quality, and increase carbon sequestration. Programs to assist landowners, incentivize tree care, and train community stewards will help ensure healthy, equitable, and sustainable urban forests that provide lasting environmental and social benefits. This measure is most appropriate for localities and nonprofits.

Measure Goals and Outcomes

Category	Outcome
Carbon Sequestration	Increased CO ₂ uptake from urban tree areas
Air Quality	Improved air quality
Biodiversity	Improve wildlife biodiversity through increased habitat
Stormwater Reduction	Increased absorption of stormwater
Public Health	Improved public health and wellbeing due to green space access and reduced impacts of extreme heat.

Key Actions

Urban Trees Expansion

- **NEAR-TERM** Establish local and regional tree canopy cover targets, possibly tailored to different land use types.
Key Actors: Localities, nonprofits, regional entities
 - Incorporate and build on the existing tree canopy cover plans, such as Petersburg’s Strategic Tree Canopy Plan and the Richmond 300 Master Plan
- **NEAR-TERM** Develop a regional urban reforestation initiative in partnership with local governments, nonprofits, and community groups to prioritize tree planting in areas with low canopy coverage and high urban heat island effects. **Key Actors:** Localities, nonprofits, regional entities

Petersburg Tree Canopy Plan

In 2025, the City of Petersburg adopted a [Tree Canopy Plan](#) for maintaining 43% tree canopy coverage through 2045. The City is committed to expanding equitable access to tree benefits by increasing tree canopy in low-canopy communities. The plan includes recommendations to prevent “green gentrification,” a process in which beautification projects and new green spaces lead landlords to raise rents high enough to displace existing residents.

Tree Preservation & Maintenance

- **NEAR-TERM** Create programs to assist private landowners in maintaining and preserving their trees. Offer incentives for tree care and penalties for the removal of healthy trees. **Key Actors:** Localities.
- **NEAR-TERM** Implement cutting-edge techniques to reduce the costs of maintaining urban trees and enhance carbon sequestration. For instance, use biochar as a soil amendment to boost carbon storage and improve tree health where suitable. **Key Actors:** Localities, nonprofits, private businesses
- **NEAR-TERM** Develop local tree preservation ordinances protects mature trees, requires replacement plantings for removals, and includes penalties for unauthorized tree removal. **Key Actors:** Localities
 - The [City of Richmond's Code of Ordinances](#) includes provisions for the maintenance and removal of trees on city-owned property, aiming to protect and manage the urban forest effectively.
- **NEAR-TERM** Establish a certified tree steward program to train volunteers in tree care, maintenance, and community engagement to support urban forestry initiatives. **Key Actors:** Localities, nonprofits
 - The [Richmond Tree Stewards](#) is a volunteer organization dedicated to promoting healthy urban forests through education and advocacy. Volunteers are trained in tree care and maintenance, playing a vital role in supporting the city's urban forestry programs



The LEGO Group partnered with Chesterfield County, VA on a reforestation effort where 1,440 trees were planted (The LEGO Group celebrates parkland reforestation project near its Virginia, USA, site in ceremony with local officials, 2024). Source: PlanRVA

Possible Output metrics

Metric
Number of urban tree canopy cover targets set and adopted by local jurisdictions
Number of trees planted through reforestation initiatives
Number of communities engaged in urban forestry and tree planting efforts
Number of tree preservation and maintenance programs established for private landowners
Acres of land treated with biochar or other soil amendments to enhance tree health
Acres of forested land preserved
Percent of residents within 0.5 miles of public green space
Number of municipalities adopting regional tree preservation ordinances
Number of volunteers trained through certified tree steward programs

NWL5. Increase soil conservation and nutrient management practices in agriculture.



2025-2050 GHG reductions: 0.9 MMTCO₂e



This measure focuses on improving soil carbon sequestration, environmental health, and farm productivity by increasing soil-conserving practices and optimizing nutrient use to reduce nitrous oxide (N₂O) emissions. By implementing advanced nutrient management practices and supporting soil-building techniques like cover cropping and improved tillage, the measure aims to increase nitrogen use efficiency, minimize excess fertilizer application, and promote sustainable, resilient farming systems. These strategies help lower emissions, enhance soil productivity, and support long-term agricultural and environmental health.

This measure is strongly aligned with the requirements of localities under the Chesapeake Bay Preservation Act²⁹ (CBPA) and Virginia’s efforts to accomplish the Chesapeake Bay Watershed Improvement Plan³⁰ (WIP III). The CBPA requires localities in the eastern portion of the region to plan and adopt ordinance provisions to protect the quality of state waters in the Chesapeake Bay watershed. Per the CBPA, localities beyond the Tidewater are enabled to adopt these provisions. Agricultural landowners in Virginia are encouraged to work with local SWCDs to develop conservation assessments and implement recommendations including nutrient management plans and best management practices. Costs for implementation can be reduced through SWCD cost-share programs.

By encouraging the integration of trees and shrubs into agricultural landscapes, supporting practices such as silvopasture and streamside forest buffers, and advocating for sustained policy and funding support, this measure aims to enhance soil health, reduce erosion, sequester carbon, and protect water quality. These efforts help build more resilient and sustainable farming systems while supporting biodiversity and long-term economic benefits for agricultural communities. This measure is most appropriate for private businesses, regional entities, and state agencies.

Measure Goals and Outcomes

Category	Outcome
Soil Health	Improved soil health, fertility, and organic matter, leading to more productive and resilient agricultural lands
Reduced Erosion	Minimize soil loss from wind and water, protecting valuable topsoil
Carbon Sequestration	Increased carbon sequestration in both soil and vegetation
Long-Term Sustainability	Encourages farming practices that balance productivity with long-term environmental stewardship
Resilience	Help farms withstand climate stresses through improved soil health

²⁹ <https://www.deq.virginia.gov/water/chesapeake-bay/chesapeake-bay-preservation-act>

³⁰ <https://www.deq.virginia.gov/water/chesapeake-bay/phase-iii-wip>

Category	Outcome
Water Quality	Improved water quality via riparian buffers and decreased nitrogen runoff into waterways, which reduces algal blooms
Nitrous Oxide Emissions	Reduce nitrous oxide emissions
Crop Yield	Increased crop yields and crop quality

Key Actions

Agroforestry and Sustainable Land Use

- **NEAR-TERM** Implement silvopasture practices³¹: Integrate trees into grazing areas to sequester carbon and enhance soil health. **Key Actors:** Private businesses
- **NEAR-TERM** Establish streamside forest buffers: Plant native trees and shrubs along waterways, maintaining at least a 35-ft buffer. These absorb and runoff, therefore limiting subsequent N₂O emissions, preventing erosion, and providing habitat. **Key Actors:** Private businesses, regional entities, state agencies
- **VISIONARY** Study the potential for agroforestry in the region to identify opportunities for integrating trees and shrubs into agricultural landscapes for environmental and economic benefits. **Key Actors:** Nonprofits, private businesses, regional entities, state agencies

Planting Along the James River

The [James River Association's Streamside Forests program](#) assists landowners in planting native trees and shrubs along waterways. These riparian buffers, maintained at a minimum of 35 feet, absorb runoff, reduce nitrous oxide emissions, prevent erosion, and provide vital wildlife habitats.

Policy and Funding

- **NEAR-TERM** Advocate for the continued support of the DCR Agricultural Incentives Program and other state funding for soil and water conservation practices. **Key Actors:** Nonprofits, private businesses, state agencies
- **VISIONARY** Encourage adoption of CBPA requirements beyond the Bay watershed. **Key Actors:** Nonprofits, regional entities

Soil Health and Nutrient Management

- **NEAR-TERM** Increase adoption of nutrient management strategies. Nutrient management strategies reduce N₂O from agricultural soils by i) enabling better nitrogen use efficiency (NUE) so there is less nitrogen available in the soil for N₂O generating processes, and ii) enabling less total nitrogen to be applied due to better NUE. Nutrient management strategies include:
 - Nitrification inhibitors
 - Enhanced efficiency fertilizers
 - Controlled release of nitrogen fertilizers
 - Split nitrogen applications to align with nutrient uptake timing**Key Actors:** Private businesses, regional entities, state agencies
- **NEAR-TERM** Increase the use of cover crops and no- or low-till practices. Cover crops and changes in tillage management practices can also affect soil N₂O emissions due to more nitrogen fixation by plants which

³¹ <https://www.cbf.org/issues/agriculture/eight-key-conservation-practices-used-in-regenerative-agriculture.html>

return nitrogen to the soil and therefore increase nitrogen availability in the soil for future growth cycles. However, both practices predominantly affect soil organic carbon. Cover crops such as rye, clover, or radishes when planted in off-seasons can prevent soil erosion, fix nitrogen, and enhance microbial life. **Key Actors:** Private businesses, regional entities, state agencies

Possible Output Metrics

Metric
Miles of streamside forest buffers planted
Acres of cropland using cover cropping to prevent erosion
Acres of silvopasture established
Acres of farmland using precision nutrient management
Number of farms adopting no-till or low-till practices
Acres of cropland using cover cropping to reduce erosion and fix nitrogen

NWL6. Support livestock management strategies that reduce emissions.



2025-2050 GHG reductions: 0.4 MMTCO₂e



This measure aims to reduce GHG emissions from livestock operations by improving how manure is handled and by advancing sustainable grazing practices. This measure promotes the adoption of technologies and management approaches such as anaerobic digesters to capture methane, reducing manure storage time, and implementing rotational grazing. These strategies lower emissions of methane and nitrous oxide from manure and pasture systems. By supporting both technological solutions and conservation practices, the measure helps farms generate renewable energy, improve soil and water quality, and build more resilient and sustainable livestock operations. This measure is most appropriate for private businesses, regional entities, and state agencies.

Measure Goals and Outcomes

Category	Outcome
Methane Reduction	Reduction in methane emissions due to livestock operation improvements
Water Quality	Improved water quality by reducing nutrient runoff
Soil Health	Improved soil health due to rotational grazing
Renewable Energy	Renewable energy generation from biogas from anaerobic digester

Key Actions

Manure Management Emissions Reduction

- **NEAR-TERM** Increase adoption of anaerobic digesters to capture methane produced during manure storage. Anaerobic digesters are predominantly relevant for dairy cattle and swine operations that manage manure as a liquid or slurry and collect at a single location. Methane captured can be used as biogas and offset energy needs from other energy sources for farm operations. **Key Actors:** Private businesses, regional entities, state agencies
- **VISIONARY** Study the applicability of reduced manure storage time strategies in the MSA's climate. There are trade-offs between decreased storage time, which minimizes methane production, and nitrous oxide emissions when manure is spread on soils, but the balance can be favorable in the right conditions. **Key Actors:** Private businesses, regional entities, state agencies
 - Daily spread of manure will result in the highest potential for this mitigation strategy but if manure is stored for longer periods (months), reducing storage time by days to weeks is also beneficial. Decreasing manure storage time is more relevant in warmer climates with favorable land application conditions N₂O emissions can increase if manure is applied to agricultural soils so assessment of the GHG synergies and trade-offs is necessary to determine if this is a viable emissions reduction strategy.

Oakmulgee Dairy Farm

The [Oakmulgee Dairy Farm](#) in Amelia is the oldest continuously operating family dairy farm in Virginia, run by the Moyer family. An anaerobic digester produces renewable natural gas (RNG) from cow manure and waste from a local winery. The RNG replaces fossil fuel use at a pharmaceutical partner facility. The Moyers strongly believe that sustainable and innovative practices, like their digester, are the key to economic longevity in the agriculture industry.

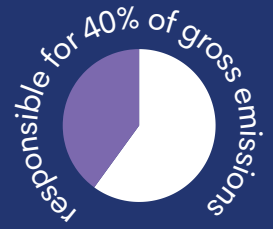
Grazing and Pasture Management

- **NEAR-TERM** Increase the adoption of sustainable grazing practices. Leverage Chesapeake Bay Foundation's (CBF) [Mountains-to-Bay \(M2B\) Grazing Alliance](#) and continue to advocate for state funding of the Agricultural Incentives Program to support sustainable farming. **Key Actors:** Private businesses, regional entities, state agencies
 - Promote rotational grazing and related conservation practices
 - Implement forested buffers and livestock stream exclusion practices.
 - Provide outreach and technical assistance through farmer-to-farmer mentoring, on-farm demonstrations, and peer-to-peer experiences.
 - Explore mechanisms to ensure the longevity of the M2B Grazing Alliance beyond the grant period.

Possible Output Metrics

Metric
Number of methane digesters installed to capture emissions from manure storage
Acres of cropland converted to rotational grazing through M2B Grazing Alliance

TRANSPORTATION EMISSIONS OVERVIEW



What are the main sources of transportation emissions in Richmond?



LIGHT DUTY VEHICLES

Responsible for **52%** of transportation emissions



HEAVY DUTY VEHICLES

Responsible for **30%** of transportation emissions.



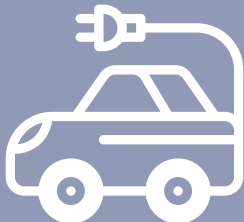
CONSTRUCTION VEHICLES

Responsible for **3%** of transportation emissions



BUSES

Responsible for **1.5%** of transportation emissions.

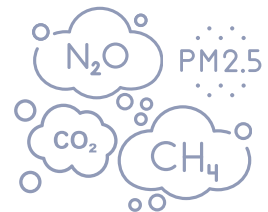


84,936 REGISTERED ELECTRIC VEHICLES

As of September 2024, there are 84,936 registered electric vehicles in Virginia, according to the U.S. Department of Energy.

Air quality impacts from tailpipe emissions

In addition to greenhouse gases, gasoline and diesel vehicles release other pollutants, such as particulate matter, that contribute to poor air quality and smog.



These pollutants can have negative consequences for our communities' health, leading to higher rates of asthma and other illnesses.

TRANSPORTATION MEASURES

WHAT ARE TRANSPORTATION'S MAIN SUB-SECTORS?

And what percentage of emissions are they responsible for?



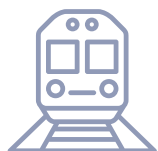
ON- & OFF-ROAD VEHICLES

Responsible for **96%** of transportation emissions



AVIATION

Responsible for **3%** of transportation emissions.



RAIL

Responsible for **0.5%** of transportation emissions



MARINE

Responsible for **0.5%** of transportation emissions.

HOW DOES RICHMOND PLAN TO REDUCE EMISSIONS?



Reduce emissions from **port operations** through the adoption of low-carbon fuels, electric equipment, and operational changes



Support, incentivize, and provide assistance for the rapid adoption, equitable installation, and use of **zero-emission vehicles**.



Expand equitable **transit** access.



Provide and promote new and expanded opportunities to reduce vehicle miles travelled through **micromobility** options and micro modal infrastructure (e.g., electric bikes and scooters)



Expand use of **low-carbon transportation materials**.

TRANSPORTATION IMPLEMENTATION PARTNERS

STATE PARTNERS



VDOT is responsible for the planning, design, construction, and maintenance of transportation projects across all travel modes.



DRPT funds and regulates transportation projects.



Dominion Energy supports EV infrastructure development through incentive programs and partnerships with state agencies.

LOCAL PLANNING PARTNERS



RRTPO is responsible for planning for the MSA's transportation sector in the near term and long term.



CPDC is a contributing force to planning efforts in eleven member jurisdictions and covers the southern region of the MSA.



CVTPO coordinates with the Richmond MSA on transportation needs and planning.



FAMPO coordinates with the Richmond MSA on transportation needs and planning.



Tri-Cities MPO conducts long term transportation planning processes for the Tri-Cities area.

FEDERAL PARTNERS



US DOT (specifically FHWA and FTA) funds and regulates transportation projects.

T1. Reduce emissions from port operations through the adoption of low-carbon fuels, electric equipment, and operational changes.



2025-2050 GHG reductions: 1 MMTCO₂e



This measure aims to reduce greenhouse gas emissions from port operations by advancing the adoption of low-carbon fuels, electrifying equipment, and implementing operational improvements. The measure supports ongoing efforts to modernize cargo handling, optimize freight movement, and reduces reliance on diesel trucks. It also supports pilot projects and partnerships to improve efficiency and sustainability throughout the regional supply chain. These efforts will not only help the port meet ambitious emission reduction targets but also improve local air quality, promote public health, and strengthen the resilience of port operations. This measure is most appropriate for regional entities and private businesses.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Operational Efficiency	Improved operational efficiency at ports
Resilience	Enhanced port resilience
Air Quality	Improved air quality

Key Actions

Reduce truck use

- **NEAR-TERM** Work with the Port of Virginia to develop sustainability initiatives for the Middle Reach of the James River and the Richmond Marine Terminal (RMT) that will reduce the number of trucks traveling between Hampton Roads (HR) and RMT. Study options for upgrading facilities to allow for larger container sizes and greater barge capacity. **Key Actors:** Private businesses, regional entities
- **VISIONARY** Conduct a commodity flow analysis for barge versus truck delivery (more barges will require capital investment at the port to expand capability); studying how storage could also be a limiting factor. **Key Actors:** Regional entities

Reducing Truck Traffic

In 2023, improvements at the Richmond Marine Terminal (RMT) allowed for increased barge service between Richmond and the Port of Virginia. This is estimated to have kept 33,500 trucks off the road, saving 3.4 million truck miles on Virginia's highways, and emitting ~30% less NO_x and 56% less CO₂ than moving freight by truck. Source: [2023 PoV Sustainability Report](#)

Analysis and pilot projects to reduce emissions

- **VISIONARY** Leverage connections with trucking industries to identify areas for incentivizing efficiency improvements and facilitating the adoption of ZEV and hybrid trucks. **Key Actors:** Private businesses, regional entities

Possible Output Metrics

Metric
Number of port vehicles transitioned to EVs
Percent reduction in trucks traveling between HR and RMT
Measure change in cargo throughput

T2. Support, incentivize, and provide assistance for the rapid adoption, equitable installation, and use of zero-emission vehicles.



2025-2050 GHG reductions: 37 MMTCO₂e

\$\$\$

To reduce emissions from the transportation sector, this measure focuses on accelerating the transition to EVs and developing a regional, equitable charging network. This measure will be supported through the creation and expansion of a robust charging network, development of incentive programs, workforce development, and other activities to encourage widespread adoption of EVs. Localities may also electrify their municipal fleets and equipment, such as school buses, public works trucks, refuse trucks, and department vehicles. Indirect co-benefits of this project, including improved public health and the creation of clean energy jobs, will spread throughout communities, with a particular emphasis on benefits to overburdened communities. These efforts will reduce transportation-related emissions, improve local air quality, and position the region as a leader in clean mobility innovation. This measure is most appropriate for localities, regional entities, state agencies, and private businesses.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Air Quality	Improved air quality via reduction in internal combustion engine vehicles
Public Health	Reduced exposure to air pollutions that contribute to respiratory illnesses and other conditions

Key Actions

EV and EV Charging Infrastructure

- **NEAR-TERM** Develop a pilot project for solar and storage charging for depot sites that may have limited grid capacity, such as school bus depots or municipal fleet depots. **Key Actors:** Localities
- **NEAR-TERM** Establish programs to support EV charging at multifamily housing complexes, following the example of the [Charge at Home](https://chargeathome.org/)³² program from Virginia Clean Cities. Remove barriers in permitting process that may be inadvertently discouraging Electric Vehicle Supply Equipment (EVSE) development at multifamily buildings. **Key Actors:** Localities, private businesses
- **NEAR-TERM** Coordinate with utilities to assess existing grid capacity to identify sites for potential EV charging facilities. **Key Actors:** Localities, private businesses, regional entities
- **NEAR-TERM** Promote ZEV and alternative fuel vehicle options in coordination with Virginia Clean Cities. Create a model ZEV procurement policy for fleet managers to adapt. **Key Actors:** Regional entities, private businesses
- **NEAR-TERM** Adopt a ZEV procurement plans for municipal fleets, school bus fleets, and public transportation fleets. **Key Actors:** Localities
- **NEAR-TERM** Pursue ChargeSmart designation at the local level to reduce the soft costs of expanding EV infrastructure. **Key Actors:** Localities
- **NEAR-TERM** Review permitting process for EVSE installation and recommend changes to streamline the process. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Develop incentives for commercial properties to install EV charging infrastructure for employees and/or the public. **Key Actors:** Localities
- **NEAR-TERM** Collaborate with Virginia Department of Transportation (VDOT) to ensure that all rest areas have EV charging infrastructure. **Key Actors:** Localities, regional entities, state agencies
- **NEAR-TERM** Update the 2013 REVI Plan for the PlanRVA region. Following that model, conduct planning assessments in the Crater region and other non-PlanRVA localities. **Key Actors:** Regional entities
- **NEAR-TERM** Expand EV charging infrastructure at public facilities. **Key Actors:** Localities

EVs and Home Charging Costs

- Typical upfront cost: \$40,000 plus \$1,200 for home-charger installation
- Typical first year operating costs: \$7,200
- Estimated lifetime savings over 15 years: \$14,700 vs. a comparable gasoline vehicle.

These savings help offset the higher upfront price, with a typical payback period of approximately 5–10 years, depending on annual mileage, electricity rates, charging access, and available incentives. See Appendix E for more information.

Charging & Fueling Infrastructure in Henrico

Henrico is the only locality in Virginia and only one of 47 localities nationally to receive a Charging and Fueling Infrastructure (CFI) grant. The county is using the \$1.4 million dollars to build 38 new EV charging ports at seven public facilities.

Across the MSA, there are 640 public charging stations, but they are unevenly distributed. 69 are free EV stations and 97 are DC Fast Chargers.

³² <https://chargeathome.org/>

- **VISIONARY** Design and develop financial incentive program for income-qualifying households to purchase used EVs. **Key Actors:** Localities, state agencies

Hydrogen refueling network

- **VISIONARY** Build out a hydrogen refueling network that can support medium and heavy-duty vehicles. These stations should consider logistical needs for primary users and connect key infrastructure in the region, such as the port, large distribution warehouses, etc. They may also be located near industrial sites that may produce or consume hydrogen in the future to centralize necessary distribution infrastructure. **Key Actors:** Localities, private businesses, regional entities

Possible Output Metrics

Metric
Number of new DC fast chargers installed
Number of ZEVs purchased for public fleets
Number of localities with EV/EV-ready building requirements
Number of localities with streamlined EVSE permitting processes
Number of hydrogen-refueling stations built
Number of businesses that purchase e-bikes for delivery services
Number of localities enrolled in the ChargeSmart program
Number of EV chargers available at public facilities

T3. Expand equitable transit access.



2025-2050 GHG reductions: 2 MMTCO₂e

\$\$\$

This measure aims to significantly increase public transit use and reduce reliance on single-occupancy vehicles by expanding and improving local and regional transit options. By improving service frequency, connectivity, and convenience, especially in key development areas, the measure will make transit the most attractive choice for longer trips. It supports the implementation of new and innovative transit solutions, such as Bus Rapid Transit (BRT), micro-transit, and enhanced rail service, while addressing service gaps and accessibility for all populations. These efforts will lower transportation-related emissions, improve mobility, and support sustainable, equitable growth throughout the region. This measure is most appropriate for localities and regional entities.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Air Quality	Improved air quality due to a decrease in vehicle miles travelled
Traffic	Reduced traffic congestion
Smart Growth	Encourages compact, mixed-use development
Mobility and Accessibility	More frequent and connected transit services provide greater access to jobs, education, and essential services, especially for underserved populations

Key Actions

- **NEAR-TERM** Make transit the most convenient mode for longer trips by providing frequent service in and between locally designated development areas consistent with [CoV §15.2-2223.1](#) **Key Actors:** Localities, regional entities
- **NEAR-TERM** Ensure the public transit experience is safe, comfortable, attractive, and accessible. Ensure all transit stops have basic amenities (i.e., shelters, benches, waste bins, etc.) and are designed for ease-of-use by all types of bodies. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Prioritize transit-oriented development, in line with the [Greater RVA Transit Vision Plan](#)³³ and the [Tri-Cities Plan 2045](#). **Key Actors:** Localities, regional entities

Public Local Transit Expansion

- **NEAR-TERM** Implement BRT project to expand the North-South corridor. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Expand micro-transit. Micro-transit refers to on-demand public transportation options that utilize dynamic routing and usually serves as a connection to fixed-route public transportation systems or may serve specific populations such as the elderly or people with disabilities. **Key Actors:** Regional entities
- **NEAR-TERM** Increase the frequency and availability of public transportation. Expand service to operate seven days per week where feasible, extend weekend service hours, and reduce wait times on existing routes to improve convenience and accessibility for riders. **Key Actors:** Regional entities
- **VISIONARY** Support RVA Rapid Transit's [Vision for a Truly Regional Public Transit System](#)³⁴. **Key Actors:** Localities, regional entities

Free Public Transit

In 2020, in response to the challenges of COVID, GRTC eliminated bus fares. The policy was so popular and successful that GRTC is now working to make buses free permanently. **Bus trips have eliminated over 5,000 metric tons of GHG emissions in the City and generate \$5 in economic returns for every \$1 invested in public transportation.** Richmond is one of a small group of cities leading the way on zero-fare public transportation, nationally, but it doesn't come without challenges. GRTC is currently fundraising to help close expected funding gaps and keep public transit free and accessible to all. For more information, visit the [Transit Access Partnership \(TAP\)](#) website.

³³ https://planrva.org/wp-content/uploads/2019/04/Greater_RVA_Transit_Vision_Plan.pdf

³⁴ <https://www.rvarapidtransit.org/>

- **VISIONARY** Improve north-south connectivity within the City and Richmond and between Richmond and Tri-Cities. **Key Actors:** Localities, regional entities

Strategy Development and Implementation

- **NEAR-TERM** Continue to study how zero-fare policies could benefit Greater Richmond Transit Company (GRTC) and PAT by increasing ridership and improving equity, and how the current zero-fare policy of GRTC can be made permanent. **Key Actors:** Regional entities
- **NEAR-TERM** Provide subsidies or other incentives to employees who utilize public transit to get to work. **Key Actors:** Localities, private businesses
- **NEAR-TERM** Continue to study gaps between micro-transit and current fixed public transportation routes. Study how well existing micro-transit and fixed route public transportation systems serve the unique needs of specific populations, including seniors, people with disabilities, youth, and women. **Key Actors:** Regional entities
- **NEAR-TERM** Implement the [Greater Richmond Transit Vision Plan](#)³⁵ network. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Implement recommendations from the [RRTPO Park & Ride Strategy](#)³⁶ for additional lots and expanded services. **Key Actors:** Local governments, regional entities

Amtrak Service Enhancement

- **NEAR-TERM** Support implementation of the proposed [Commonwealth Corridor](#)³⁷, which would expand rail service between Blacksburg, Roanoke, Charlottesville, Richmond, Williamsburg, and HR. **Key Actors:** Localities, private businesses, regional entities, state agencies
- **NEAR-TERM** Modernize rail stations and provide multimodal connections between stations and activity centers. **Key Actors:** Localities, regional entities
- **VISIONARY** Improve rail service between Richmond and HR. **Key Actors:** Private businesses, regional entities
- **VISIONARY** Improve frequency and reduce delays between Richmond and DC. Explore ways to reduce travel time and to keep fares low for this high-traffic route. **Key Actors:** Private businesses, regional entities
- **VISIONARY** Support the [Transforming Rail in Virginia \(TRIV\)](#)³⁸ project to separate freight and passenger rail service between DC and Richmond

Possible Output Metrics

Metric
Percentage of residents living within 0.5 miles of a transit stop
Percentage of transit vehicles arriving as scheduled
Number of new transit stops in underserved communities
Annual ridership of public transportation services

³⁵ Ibid.

³⁶ https://planrva.org/wp-content/uploads/RRTPO-Parkand_Ride_Strategy_12-05-19.pdf

³⁷ <https://drpt.virginia.gov/studies-and-reports/2021-commonwealth-corridor-feasibility-study/>

³⁸ <https://www.amtrak.com/transforming-rail-virginia>

T4. Reduce vehicle miles traveled through micromobility options and micro modal infrastructure.



Enabling Action with Indirect & Statewide Benefits



The most effective way to reduce emissions from the transportation sector is to reduce the number of trips made by vehicle. This measure aims to make active and low-emission travel options more accessible and appealing by investing in micromobility and micro-modal infrastructure. Through a coordinated expansion of trails, walkable connections, and neighborhood networks, the measure seeks to make non-car modes of travel the mainstream choice for short and medium-length trips. By integrating these improvements with transit and regional planning efforts, the measure supports healthier, more connected communities while advancing climate and mobility goals. This measure is most appropriate for localities, regional entities, and nonprofits.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Traffic	Decreased traffic congestion
Mobility and Accessibility	Improved micromobility options provide more equitable transport options, especially for underserved populations who may not have personal vehicles
Healthier Communities	Improved physical fitness and reduced stress among the general population

Key Actions

- **VISIONARY** Make active transportation the most convenient mode for shorter trips by completing networks in locally designated development areas consistent with [CoV §15.2-2223.1](#).

Expand Active Transportation

- **NEAR-TERM** Work with communities to identify future bike and/or pedestrian routes that can connect to the Virginia Capital Trail & Fall Line Trails – the ‘spines’ of a regional active transportation network. Identify potential ‘spurs’ of the network that connect neighborhoods to activity centers. **Key Actors:** Localities, nonprofits, regional entities
- **NEAR-TERM** Provide subsidies or other incentives to employees who utilize active transportation to get to work. **Key Actors:** Localities, private businesses

The Fall Line Trail

The Fall Line is a world-class, paved multi-use trail in Central Virginia that promises to transform the region for active transportation, connecting communities, and economic development. The 43-mile trail traverses seven localities. As of 2025, ~12% of the trail was complete, with major portions set to begin construction in 2026.

- **NEAR-TERM** Enhance the safety of existing bike infrastructure, including adding barriers between cars and bikes, installing signalized crossings and controlled mid-block crossings, and improving signage. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Complete the [Fall Line Trail](#)³⁹. **Key Actors:** Localities, regional entities

Promote walkable routes across neighborhoods

- **NEAR-TERM** Map pedestrian networks, especially as they connect to public transportation systems and public green spaces. Identify gaps and prioritize projects to fill gaps. **Key Actors:** Localities, nonprofits, regional entities
- **NEAR-TERM** Develop walkable routes between neighborhoods and transit stops (accessible sidewalk networks). **Key Actors:** Localities, regional entities
- **NEAR-TERM** Leverage the [Safe Routes to School](#) program to bring investment to improving the availability and safety of active transportation routes to public schools. **Key Actors:** Localities, nonprofits

Possible Output Metrics

Metric
Miles of new walkable routes constructed
Miles of new trails funded or constructed
Miles of protected bike lanes
Number of Active Safe Routes to School Programs

T5. Expand use of low-carbon transportation materials.



Enabling Action with Indirect & Statewide Benefits



This measure advances climate and sustainability goals in the MSA by increasing the use of low-carbon construction materials in transportation projects. Low-carbon transportation materials, also called low-embodied carbon materials, include asphalts, concrete, glass, steel and other construction materials that have lower climate impacts throughout their lifecycle⁴⁰. EPDs provide transparency on how lifecycle carbon is reduced, through either the inclusion of bio-based or recycled materials and/or more sustainable practices in the production stage. By prioritizing materials such as low-carbon asphalt, concrete, steel, and glass, the measure aims to lower the embodied carbon footprint of new and rehabilitated transportation infrastructure in the MSA. These efforts will support regional decarbonization targets, stimulate local demand for cleaner materials, and help build a more resilient transportation network. This measure is most appropriate for regional entities, state agencies, private businesses, and localities.

³⁹ <https://www.falllinetrail.org/>

⁴⁰ https://www.epa.gov/system/files/documents/2024-11/resources_lecm.pdf

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Infrastructure Durability	Improved durability of infrastructure, with fewer repairs needed over time
Cost Savings	Reduced costs from repair and maintenance

Key Actions

- **NEAR-TERM** Develop procurement policies or incentives to encourage the use of low-carbon materials in transportation projects. **Key Actors:** Localities, regional entities, state agencies
- **NEAR-TERM** Use EPDs when evaluating and selecting construction materials to consider the embodied carbon content of infrastructure projects. **Key Actors:** Localities, state agencies
- **NEAR-TERM** Provide training and technical assistance to locality staff and project partners on best practices for low-carbon material selection and reporting. **Key Actors:** Localities, private businesses, regional entities, state agencies

Low-Embodied Carbon Materials

Low-embodied-carbon (LEC) materials, such as asphalt, concrete, and other products, have significantly lower lifecycle climate impacts than traditional materials. Emissions savings come from changes in some or all the stages of material production:

- Resource extraction
- Processing
- Transportation of materials
- Manufacturing

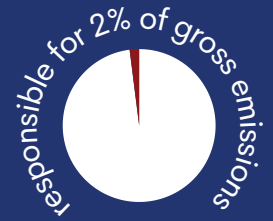
In 2023, the Virginia Transportation Research Council (VTRC) was awarded a federal grant to educate VDOT on pavement emissions quantification methods, collect production and construction data, and conduct pilot quantification efforts.

To learn more, refer to [EPA's Low Embodied Carbon Materials Resource](#) and [VDOT's Carbon Reduction Strategy](#)

Possible Output Metrics

Metric
Percentage of materials used in transportation projects that are low carbon
Cost savings from using low-carbon materials
Number of suppliers providing low-carbon materials for projects

WASTE EMISSIONS OVERVIEW



What are the main sources of waste emissions in Richmond?



SOLID WASTE

Responsible for **96%** of waste emissions



WASTEWATER

Responsible for **4%** of waste emissions.

How does the waste sector emit greenhouse gases?

Methane and other greenhouse gases are released as bacteria break down organic matter in landfills and in wastewater treatment plants. These gases are a natural byproduct of the **decomposition** process.



Methane is an especially potent greenhouse gas. Just a small amount can contribute to a more extreme warming effect, in comparison to other gases like carbon dioxide.

Waste sector co-pollutants



Landfills can contribute to the contamination of water and soils with **heavy metals** like arsenic, lead, and mercury.

Combined sewer systems, that process both stormwater runoff and sewage, can overflow during storms, leading to **raw sewage** entering waterways, posing threats to both humans and ecosystems.



WASTE MEASURES

HOW DOES RICHMOND PLAN TO REDUCE EMISSIONS?



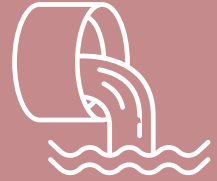
Decrease amount of waste sent to **landfills**.



Support a local **circular economy**.



Support **efficiency upgrades** at wastewater treatment plants.



RICHMOND'S WASTEWATER TREATMENT PLANT

is the largest of its kind in Virginia, with a capacity of 140 million gallons per day and serving 200,000 customers in the region. The MSA is served by 15 public wastewater treatment plants.

WHAT CAN YOU DO TO REDUCE WASTE EMISSIONS?



600,426 TONS OF WASTE were recycled in Richmond in 2020, according to Central Virginia Waste Management Authority, representing approximately 58% of total solid waste.

Plan household meals and **only buy what you need** to avoid food going bad.



Participate in municipal **composting** programs or compost at home.



Learn about **recycling best-practices** to prevent the contamination of waste streams.



WASTE IMPLEMENTATION PARTNERS

WASTE PARTNERS



Virginia Department of Environmental Quality oversees environmental regulations and policies, including those related to waste management, and works with local governments and regional agencies to develop and implement comprehensive waste management plans.



Central Virginia Waste Management Authority is a public service authority responsible for implementing solid waste management and recycling programs in the region.



Richmond's water and wastewater treatment plants are key implementation partners for emissions reductions strategies.



Virginia Department of Professional Occupational Regulations is responsible for licensing for wastewater facilities.

W1. Decrease the amount of waste sent to landfills.



2025-2050 GHG reductions: 2 MMTCO₂e



This measure aims to significantly decrease landfill-bound waste and greenhouse gas emissions by transforming how the community manages food scraps, recyclables, and other materials. By expanding access to composting, recycling, and hazardous waste programs for residents, businesses, and institutions, this measure supports a circular economy and promotes environmental equity. Financial incentives, updated ordinances, and targeted education will drive behavior change and participation. The measure also seeks to capture and beneficially use landfill gas, set ambitious diversion goals, and pilot zero-waste programs, positioning the region as a leader in sustainable waste management and climate action. This measure is most appropriate for regional entities, localities, and private businesses.

Measure Goals and Outcomes

Category	Outcome
Landfilled Waste	Reduced quantity of waste sent to landfill
GHG Emissions	Lower GHG emissions
Increased Revenue	Increased revenue from recyclable materials and landfill gas

Key Actions

Reduce food waste to landfill

- **NEAR-TERM** Establish an equitable food waste composting program available to all residents either through on-site pickup or convenient drop-off locations. **Key Actors:** Localities, nonprofits
- **NEAR-TERM** Promote public education on composting at home. **Key Actors:** Localities, nonprofits, regional entities
- **NEAR-TERM** Make organic/food waste compost, recycling, and yard waste composting available to all businesses. **Key Actors:** Localities, private businesses, regional entities
- **NEAR-TERM** Establish on-site composting programs at schools to reduce food waste and educate kids about composting. **Key Actors:** Localities, nonprofits
- **NEAR-TERM** Support large institutions, like universities, in establishing large-scale composting programs. **Key Actors:** Localities, nonprofits, private businesses

Provide financial incentives to reduce waste disposal

- **NEAR-TERM** Pass ordinances to impose a tax on plastic bags, phase out polystyrene containers, and ban balloon releases, per state-enabling legislation. **Key Actors:** Localities
- **NEAR-TERM** Re-evaluate fees for waste disposal to study how they can better incentivize personal behavior change. Explore alternative structures, such as “pay as you throw” or the option to voluntarily use a smaller curbside trash can for reduced pick-up fees. **Key Actors:** Localities, regional entities

Expand recycling programs

- **NEAR-TERM** Require contractors on public projects to divert as much construction and demolition (C&D) waste as possible from landfills. Consider creating a list of recyclable elements that should be diverted on private sector projects and incorporating that into municipal solid waste management plans. **Key Actors:** Localities, private businesses, regional entities
- **NEAR-TERM** Identify what C&D materials can be recycled in the region. Explore options for those that are not easily recycled locally, including contracting with recycling facilities outside of the region or attracting private businesses to fill market gaps. **Key Actors:** Localities, private businesses, regional entities
- **NEAR-TERM** Expand public curbside recycling to areas not currently served. Where completely infeasible, increase the proximity of drop-off locations to facilitate participation. **Key Actors:** Localities, regional entities
- **NEAR-TERM** Mandate that multifamily buildings offer recycling – and eventually composting – options on-site. **Key Actors:** Localities
- **NEAR-TERM** Establish permanent hazardous waste (e-cycle) drop-off locations for residents. Improve public understanding of what can be recycled and where. **Key Actors:** Localities, private businesses, regional entities
- **NEAR-TERM** Contract with organizations like PCs for People or Tech for Troops to recycle electronic –waste(e-waste) from localities, school systems, and corporate campuses. These organizations pick up decommissioned electronics, wipe their data, and either refurbish or recycle them, as appropriate. By selling the refurbished components to underserved markets, they help extend tools to those who otherwise would not be able to afford them. **Key Actors:** Localities, nonprofits, private businesses, regional entities
- **NEAR-TERM** Devise and implement public education campaigns and behavior-change programs to promote recycling and waste reduction. **Key Actors:** Localities, nonprofits, regional entities

Establish goals for reducing waste

- **NEAR-TERM** Commit to supporting CVWMA's goal of diverting 80% MSW by 2050. **Key Actors:** Localities, private businesses
- **NEAR-TERM** Adopt zero waste goals for localities or schools and provide model actions for employees to reduce waste. **Key Actors:** Localities, regional entities

Composting in Chesterfield, Henrico, and Richmond

Following successful pilots, several existing community recycling programs are being rolled into a new program under CVWMA.

In 2025, the program has 22 sites where residents of Chesterfield, Henrico, and Richmond can drop off their food scraps and certified compostable materials in new, purple CVWMA bins (bin at a Chesterfield drop-off site pictured below, courtesy CVWMA).

NOPE Composting Co. in Henrico services the 22 sites and composts the materials at their industrial facility, producing nutrient-rich compost for local projects.



Beneficial Use of Landfill Gas

- **NEAR-TERM** Conduct feasibility studies to assess the potential at various landfills for the beneficial use of the collected gas, instead of flaring it. Potential uses could include refining the landfill gas to make Renewable Natural Gas (RNG) or using it to generate electricity. **Key Actors:** Localities, private businesses, regional entities, state agencies
 - Explore opportunities to apply for state funding through the Priority Methane Reduction Projects (PMRP) Grant⁴¹ to support beneficial reuse of captured methane at landfills.

Pilot and scale up zero-waste programs/events

- **NEAR-TERM** Adopt zero-waste goals for large public events, such as festivals, conventions, and concerts. Support and incentivize venues to adopt their own zero-waste policies. **Key Actors:** Localities, nonprofits, private businesses
- **NEAR-TERM** Building on the award-winning pilot project at Henrico Doctor’s Hospital, work with hospital systems to recycle non-biohazardous materials. Hospital systems, research institutions, and pharmaceutical developers can also adopt waste management plans and institute procurement practices that reduce waste. **Key Actors:** Private businesses, regional entities

Possible Output Metrics

Metric
Percentage of documented recycling and waste disposal information maintained
Number of waste diversion programs created
Number of composting zones established
Percentage of C&D waste diverted from landfills annually
Number of waste reduction educational programs established
Increase in community awareness and participation in waste reduction and recycling initiatives
Percent of residents served by curbside recycling
Number of recycling drop-off locations
Tons of e-waste diverted from landfills
Volume of compost collected

W2. Support a local, circular economy.



Enabling Action with Indirect & Statewide Benefits



This measure seeks to lay the foundation for a local circular economy by evaluating how plastics, paper, and other materials can be collected and processed by local industries for reuse. Through comprehensive analysis of waste streams, materials flow, and current management practices, the measure will identify opportunities

⁴¹ <https://www.deq.virginia.gov/air-energy/climate-pollution-reduction-grant/project-implementation-grants>

to reduce landfill disposal, recover valuable resources, and support new business models. By partnering with local businesses and exploring innovative reuse and recycling initiatives, the measure aims to strengthen regional manufacturing, reduce emissions, and create a more sustainable, resilient community. This measure is most appropriate for private businesses, regional entities, and localities.

Measure Goals and Outcomes

Category	Outcome
GHG Emissions	Reduced GHG emissions
Landfilled Waste	Less waste sent to landfill
Resource Efficiency	Improved resource efficiency through reuse and recycling
Resilience	Greater supply chain resilience through localized material flows

Key Actions

Conduct comprehensive analysis to assess waste reduction potentials

- **NEAR-TERM** Conduct a comprehensive analysis of waste generation, composition, and management practices across the MSA to identify areas for improvement and opportunities for waste reduction. **Key Actors:** Private businesses, regional entities
- **VISIONARY** Study waste flow in and out of the region to better understand the impact of imported and exported waste. **Key Actors:** Private businesses, regional entities
- **NEAR-TERM** Assess current woody material disposal practices and develop initiatives to increase the reuse of woody materials, such as creating mulch, compost, or bioenergy. **Key Actors:** Localities, nonprofits, regional entities

Explore private sector partnerships to enhance local waste reduction efforts

- **NEAR-TERM** Support and participate in re-use and secondary markets such as ReStores, Repair Cafés, the EPA & BCSD Materials Marketplace, Rheaply, or the VDEQ Business Exchange Program. **Key Actors:** Localities, nonprofits, private businesses
- **NEAR-TERM** Support efforts to establish a regional circular economy for rare earth minerals. Identify potential locations for hubs where electronics waste could be collected, disassembled, and refined for resale to support local manufacturing and improve the security of critical supply chains of national importance. **Key Actors:** Localities, nonprofits, private businesses, regional entities
- **NEAR-TERM** Investigate the feasibility and potential impact of container return programs for bottles, cans, and hard plastic containers. **Key Actors:** Localities, regional entities, state agencies

Critical Minerals Recycling

The [Circular Supply Chain Coalition](#) is advancing new methods to recover rare earth and battery-critical minerals from discarded electronics. With the Virginia Commonwealth University (VCU) Circular Supply Lab as a key partner, the coalition is exploring a Richmond-based hub for this work. This initiative could position the region to lead in circular-materials innovation, strengthen domestic supply chains, and create future green-economy opportunities.

- **NEAR-TERM** Work with paper and pulp producers to devise improvements to waste management and recycling programs that would ensure cleaner, higher volume recoverable materials stream for their use. **Key Actors:** Private businesses, regional entities
- **NEAR-TERM** Educate and encourage institutions and businesses with large amounts of IT equipment to leverage free IT equipment return and/or recycling programs offered by major IT vendors (Hewlett Packard Enterprise (HPE), Dell, Oracle, IBM, Cisco, etc.). **Key Actors:** Localities, nonprofits, private businesses, regional entities
- **VISIONARY** Support emerging EV battery recycling market by attracting businesses that will collect and recycle EV batteries in the region. **Key Actors:** Localities, private businesses, regional entities

Possible Output Metrics

Metric
List of improvements for waste management of the MSA is created and is updated regularly.
Circular economy tracker developed and frequently updated.
Number of private-public partnerships established for local waste reduction.
Volume of factory waste reduced.

W3. Support efficiency upgrades at wastewater treatment plants.



2025-2050 GHG reductions: 0.04 MMTCO₂e



This measure focuses on improving the operational efficiency and sustainability of wastewater treatment plants (WWTPs) by targeting energy use and resource recovery. Through comprehensive energy audits, strategic retrofits, and the adoption of smart technologies, the measure aims to reduce energy consumption and operating costs. Additionally, it advances the capture and conversion of waste gases into renewable energy, supporting a transition toward self-sufficient and climate-friendly wastewater operations. Pilot programs and feasibility studies will further explore innovative solutions, such as biogas production, to maximize environmental and economic benefits for the region. This measure is most appropriate for localities.

Measure Goals and Outcomes

Category	Outcome
Energy Consumption	Lower energy consumption from WWTPs
GHG Emissions	Reduced GHG Emissions
Air Quality	Improved air quality through capture of waste gas

Key Actions

Conduct Energy Audits and Upgrades

- **NEAR-TERM** Complete energy audits on all facilities, identifying opportunities for energy retrofits across its facility portfolio, and integrate findings into capital improvement planning. **Key Actors:** Localities
- **NEAR-TERM** Evaluate the benefits and feasibility of using a contracting method, such as an energy-savings performance contract or energy as a service, to bundle and fund (and potentially identify) energy retrofits. **Key Actors:** Localities
- **VISIONARY** Implement Smart Technology Upgrades. Some upgrades that could be implemented in regional facilities include advanced monitoring systems, automated controls, and energy-efficient machinery. **Key Actors:** Localities

Capture and convert waste gases

- **VISIONARY** Develop a comprehensive program to capture and convert waste gases from WWTPs into renewable energy sources, such as biogas, to reduce emissions and generate sustainable energy. **Key Actors:** Localities

Remediate residential septic systems

- **NEAR-TERM** Identify septic systems in need of maintenance, pump-outs, or remediation to reduce methane emissions and protect water quality. Prioritize septic systems at risk of climate-related impacts such as flooding from sea level rise or riverine flooding. **Key Actors:** Localities, regional entities

Renewable Methane from Henrico and Richmond

Henrico and Richmond are investigating ways to repurpose methane generated at wastewater facilities rather than flare it. Henrico County’s Water Reclamation Facility is conducting a 2025 feasibility study on converting its surplus biogas into marketable energy, while Richmond’s Department of Public Utilities completed a 2024 engineering analysis and is reviewing firms capable of purifying its digester gas for energy use.

Possible Output Metrics

Metric
A WWTPs program developed (Y/N)
Reduction in operational costs due to energy savings
Enhanced monitoring and control of wastewater treatment processes
Increased energy efficiency of wastewater treatment plants
Number of energy audits conducted and resulting amount of energy savings potential and upgrades identified
Number of residential septic systems remediated

Co-Benefits Analysis



Co-Benefits

Sources of greenhouse gases are also sources of other classes of pollutants that can harm public health and the environment. Criteria Air Pollutants (CAPs) and Hazardous Air Pollutants (HAPs) have widespread public health impacts, including increased incidents of respiratory and cardiovascular diseases, asthma exacerbation, cancer, and premature death. Like a GHG inventory, tracking these co-pollutants in an inventory over time provides an understanding of what pollutants are being released, how much, and their key sources. See Table 1 for a summary of co-pollutant emissions in the region by sector and pollutant, with a focus on CAPs. Reducing CAPs improves health outcomes, reduces healthcare costs, and improves livelihoods and quality of life. CAPs were prioritized in this report due to their regulatory significance and the availability of robust emissions factors and monitoring methods. Because GHGs, CAPs, and HAPs, frequently come from the same sources, strategies to reduce GHGs also result in decreased CAPs and HAPs.

This section presents estimations of the health benefits and monetary savings that may result from reductions in co-pollutant, based on the Net Zero Scenario. The MSA-wide results provide an aggregated view of total emissions reductions and health impacts across all sectors. Sector-specific analyses detailing the contributions of individual sectors to both pollutant reductions and public health improvements can be found in the Appendix B.

Key co-benefits of implementing the Air Quality Plan:

- **Health Improvements:** fewer asthma attacks, hospital visits, heart and lung diseases, and premature deaths, with a potential value of \$8 - \$13 billion.
- **Economic Gains:** reduced medical costs, improved worker productivity, and new clean energy jobs.
- **Community Resilience:** cleaner indoor and outdoor air, greater energy reliability, cooler neighborhoods, and improved natural systems.

Transitions to low-carbon technologies provide far-reaching benefits. By reducing air pollutants, these measures may improve respiratory and cardiovascular health, enhance day-to-day quality of life, and build more resilient communities. Across sectors, the shift away from fossil fuels has the potential to cut pollution at its source and bring meaningful improvements to both local environments and public well-being. Together, these sector-wide transitions deliver substantial air-quality, health, and resilience gains alongside climate progress.

In **transportation**, vehicle electrification eliminates tailpipe emissions and reduces noise, improving air quality and livability in neighborhoods near busy roads. **Building** electrification lowers indoor and outdoor exposure to combustion-related pollutants. A clean, electric **power** sector reduces pollution from fossil plants, strengthens grid resilience and reliability, and can mitigate rising energy bills. **Industrial** facilities that adopt cleaner fuels and more efficient processes reduce pollution burdens on nearby communities, while improved **waste** practices curb methane and co-pollutants and create opportunities for biogas and compost use. Sustainable **agricultural** practices restore soil health, reduce emissions, protect water and land resources, and improve resilience to extreme weather. Finally, investing in **trees** and better **green spaces** cools neighborhoods, improves air quality, mitigates flood hazards, and provides social and mental benefits to nearby communities. Together, these sector-wide transitions deliver substantial air-quality, health, and resilience gains alongside climate progress.

Health impact estimates, derived from EPA's Co-Benefits Risk Assessment (COBRA) tool, include incidence counts and monetized benefits across categories such as mortality, hospital visits, restricted activity days, and respiratory/cardiovascular conditions. COBRA is a screening tool developed by the EPA to estimate the health and economic benefits of air quality improvements. COBRA models the impact of changes in emissions of CAPs (e.g., PM_{2.5}, SO₂, NO_x, VOCs) on public health outcomes and monetizes these benefits using peer-reviewed, concentration-response functions and economic valuation methods⁴².

In addition to health benefits from air pollution removals, the **NWL sector** provides ecosystem services in the form of avoided runoff, rainfall interception, and transpiration, which helps combat urban heat island effects, enhance stormwater management by managing water volume, and improve water quality by reducing stormwater runoff and promoting infiltration. To assess the co-benefits of NWL, EPA's i-Tree Landscape Module was used to estimate ecosystem services provided by increased tree cover. By 2050, the modeled tree canopy expansion could result in avoided runoff benefits reaching over \$34 million per year. The results of the air pollutant removals are included in Table .

The measures also have the potential for substantial **socioeconomic** benefits. For example, clean energy can be developed to improve grid resilience (e.g., through battery storage), reducing the risk of blackouts and promoting energy independence.⁴³ Consequently, these investments mitigate the economic and physical impact of extreme weather events. Additionally, reducing GHG emissions over the long term can help increase climate resilience and lessen occurrences of events like extreme precipitation and storms. This, in turn, can prevent additional costs such as higher insurance premiums, expenses for repairing structural damage, and losses in crops and natural resources. The reduction of extreme weather events also alleviates costs related to medical bills and premature deaths.

Implementing the measures in this plan across all sectors would lead to reductions of all CAPs by 2050. Table 3 shows the cumulative reductions by pollutant. For most CAPs, reductions are caused by declines in fossil fuel combustion (changes in energy use). Co-pollutants are also reduced by natural processes. As nature-based solutions are implemented in accordance with the Air Quality Plan, the capacity of our Natural and Working Lands to remove pollutants from the ecosystem increases (Removals from NWL).

Table 4 presents the monetized health benefits due to the lower co-pollutant emissions, which may range from \$8 - \$13 billion. The alleviation of these pollutants will positively impact the physical and economic wellbeing of communities.

Table 3: Cumulative Changes in Co-Pollutant Emissions (MT) by Pollutant, 2025-2050

Pollutant	Cumulative Reductions from Change in Energy Use	Removals from NWL
NOx	43,228	35,218
SO ₂	42,381	20,585
PM	22,740	73,548
CO	35,136	5,945
Lead	0.52	35,218
VOC	1,825	n/a

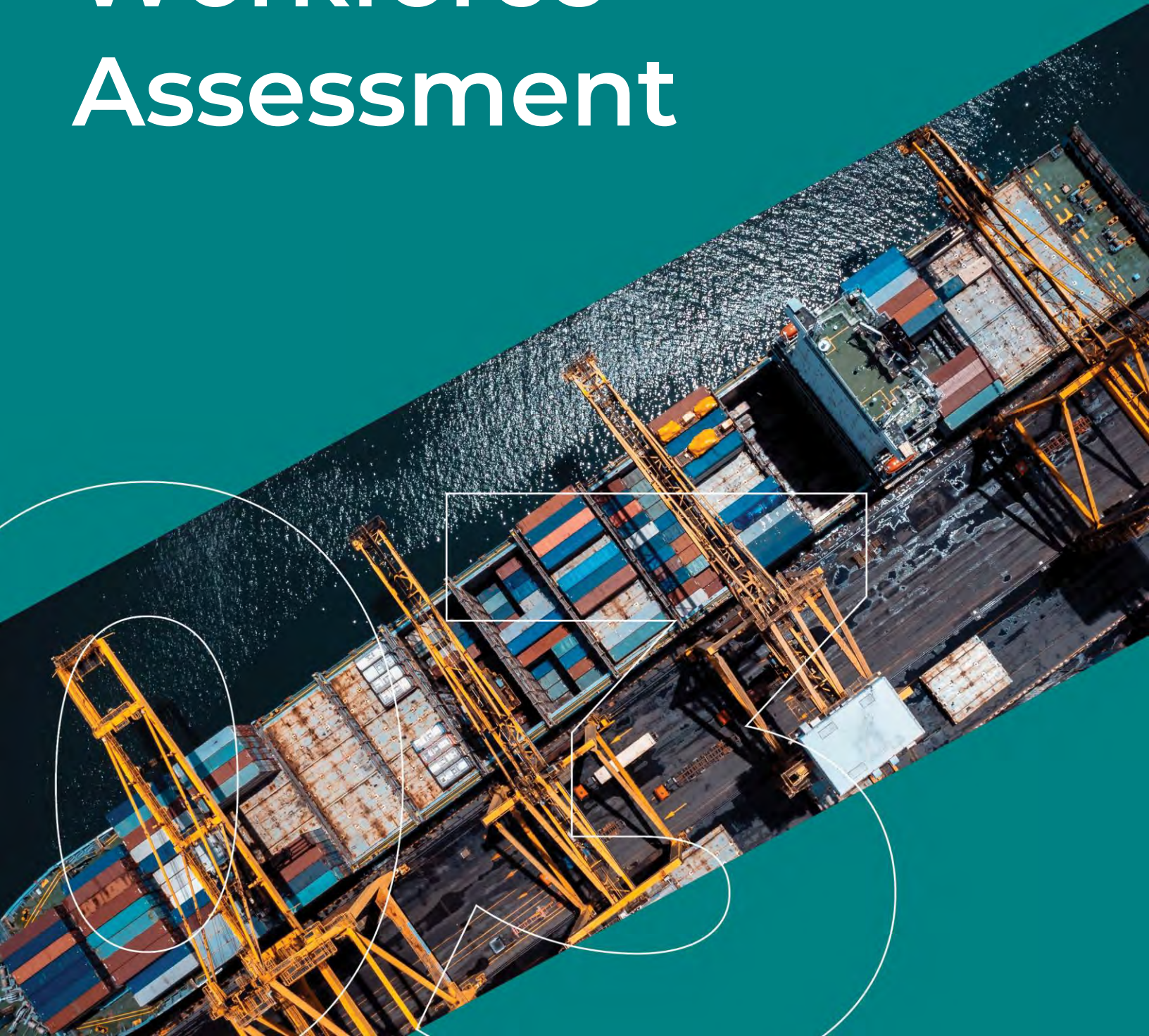
⁴² <https://www.epa.gov/cobra/how-does-cobra-work-0>

⁴³ NREL. 2018. *Distributed Energy Planning for Climate Resilience*. <https://www.nrel.gov/docs/fy18osti/71310.pdf>

Table 4: Cumulative Monetary Health Benefits (Million \$) and Incident Reductions, 2025-2050

Health Impact	Cumulative Monetary Benefits (2025-2050)	Cumulative Incidence Reduction (2025-2050)
Mortality	\$ 7,467 - \$ 12,740	511 - 876
Hospital Visits	\$ 7	1,212
Missed School/Work or Restricted Activity	\$ 273	427,548
Cardiovascular Conditions	\$ 19	227
Respiratory Conditions	\$ 270	380,885

Workforce Assessment



Workforce Analysis

Assessing workforce readiness to support implementation of the Air Quality Plan measures is critical for success. If the workforce supply lags behind demand induced by implementation, then progress towards the goals of the plan could be slowed. It is also very important that new jobs in the clean economy primarily benefit existing residents and workers, especially our local underemployed and under-resourced communities. This section focuses on occupations that are likely to be directly impacted by the plan measures, identifies potential gaps in worker availability and training, and outlines a solutioning.

This workforce analysis provides information to help the region proactively plan for future workforce needs. Economic development entities, labor associations, and educational entities are best poised to act on these insights. The Air Quality Plan is projected to impact nearly 60 different occupations ranging from bus drivers to construction and skilled trades. In total, these occupations represent roughly 82,500 jobs or 11.2% of total jobs in the MSA.

The workforce gap analysis uses data on projected growth (the number of workers needed to fill new openings), separations (employees leaving the workforce/occupation), and hires to estimate the shortage or surplus of workers for each of the 60 occupations. The workforce gap analysis only considers existing conditions in the labor market and does not factor in additional demand for workers that implementing the measures could generate. If labor market trends were to remain static, this would mean that any existing gaps would be expected to widen, and any surpluses could tighten.

Key Findings

Currently, the Richmond MSA's labor market is well balanced without critical gaps in the industries touched by the Air Quality Plan. The analysis indicates that occupations with estimated shortages include **Heavy Tractor-Trailer Truck Drivers, Construction Laborers, Carpenters, and First-Line Supervisors of Construction** in the buildings sector and **Miscellaneous Assemblers and Fabricators and Chemical Equipment Operators** in the industry sector. The workforce shortages in these occupations are minor (less than 2% of all workers in the occupation), except for Chemical Equipment Operators where it represents 2.7% of all workers in the MSA for that occupation.

In contrast, workforce surpluses in the region for the Air Quality Plan occupations are relatively more prominent. Laborers and Freight, Stock, and Material Movers is estimated to have the largest surplus, 636 workers or 5.5% of the total workforce in that occupation. Surpluses also are estimated for Light Truck Drivers, Supervisors or Transportation and Material Moving Workers, Electricians, Landscaping Workers, and Civil Engineers. A full list of occupations analyzed for this report can be found in Appendix C.

Although the current labor market has minor gaps, the analysis indicates that these gaps can potentially be exacerbated with the Air Quality Plan implementation. For instance, the current largest shortage of workers in the MSA is for Heavy Tractor-Trailer Truck Drivers (-219), which represents almost 2% of the total number of workers in the occupation in the MSA. Heavy Tractor-Trailer Truck Drivers are vital to implementing measures within the waste sector and the labor shortage could pose challenges in the near future. Since many of the workforce overages and the greatest workforce shortage are in the transportation sector, it is a great opportunity to utilize transferable skills to fill gaps. Creating pathways for professional development within sectors makes it easier individuals pivot careers and fill necessary vacancies.

Federal labor data, used for this analysis, does not show the whole picture. A major limitation is the lack of nuance in jobs codes. Coding can be broad and tends to lag well behind evolutions in job specialization. A critical example of this is for HVAC professionals and electricians. While federal data shows that the Richmond MSA is well supplied with HVAC professionals, and is slightly oversupplied in electricians, the SOC Codes make no distinction for HVAC technicians trained to install heat pumps, specifically, or for master-level electricians. Those sub-qualifications are of particular importance to the measures of the Air Quality Plan. Anecdotal evidence from the workforce webinar and survey indicate that professionals with these specific skills are undersupplied in the region. Similarly, implementation of the Air Quality Plan will likely increase demand for mechanics trained to work on EV cars and alternative fuel medium- and heavy-duty vehicles. Federal data shows the region is sufficiently supplied with mechanics, but does not give us insight into how many mechanics have those particular skills.

Table 7: Occupations with Largest Workforce Shortages 2025

SOC Code	Occupation	Relevant Sector	Potential Workforce Shortage	Potential Shortage as % of Total Employment
53-3032	Heavy and Tractor-Trailer Truck Drivers	Waste	-219	1.9%
47-2061	Construction Laborers	Buildings	-32	0.5%
51-2098	Miscellaneous Assemblers and Fabricators	Industry	-31	1.2%
51-9011	Chemical Equipment Operators and Tenders	Industry	-13	2.7%
47-2031	Carpenters	Industry, Buildings	-12	0.3%
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	Transportation, Buildings	-10	0.2%

Table 8: Occupations with Largest Workforce Surplus 2025

SOC Code	Occupation	Relevant Sector	Potential Workforce Shortage	Potential Shortage as % of Total Employment
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	Transportation	636	5.5%
53-3033	Light Truck Drivers	AFLOU	185	3.4%
53-1047	First-Line Supervisors of Transportation and Material Moving Workers, Except Aircraft Cargo Handling Supervisors	Transportation	70	2.3%
47-2111	Electricians	AFOLU, Transportation, Buildings, Energy	64	1.7%

SOC Code	Occupation	Relevant Sector	Potential Workforce Shortage	Potential Shortage as % of Total Employment
37-3011	Landscaping and Groundskeeping Workers	AFLOU	57	1.0%
17-2051	Civil Engineers	Buildings	56	2.4%

Addressing Workforce Shortages and Surpluses for the Air Quality Plan Measures

Addressing these shortages will ensure successful implementation of the Air Quality Plan, and it is important to plan for these gaps by expanding early education career programs, providing technical training, and offering mentorship.

Workforce Training

The most immediate solution to address potential workforce imbalances is to develop additional training for existing workers in occupations where there are surpluses or shortages. Bridging these gaps provides opportunities for workers in oversupplied professions to develop professionally and work in areas projected to grow through Air Quality Plan implementation. Switching careers can also provide community members with access to higher paying jobs and increased opportunities for career growth. Matching skills within sectors can ensure that these transitions can be made with little additional training. Examples of careers with transferable skills that could address workforce gaps include:

- Laborers and Freight, Stock, and Material Movers where there is a relatively large surplus of workers in the region who can be reskilled for Construction Laborers, where there are shortages.
- Retraining Light Truck Drivers for Heavy and Tractor-Trailers.

Training building automation design professionals would also help accelerate Air Quality Plan implementation. One shortage emphasized within the workforce survey was the need for more building automation design professionals. Automation design professionals operate in a wide range of industries, but in this context, they create automated systems such as HVAC, lighting, and energy management in buildings. The current gap for this role may be exacerbated by Air Quality Plan implementation if not addressed.

Soft Skills

Feedback gathered through stakeholder engagement consistently highlighted the importance of soft skills for the emerging workforce. While most workforce development programs track technical credentials and industry-specific qualifications, employers report that soft skills—such as communication, teamwork, problem-solving, adaptability, and professionalism—are equally critical to job performance. These skills are also among the most difficult to teach once an employee is already in the workplace. As a result, gaps in soft skills can limit advancement opportunities for otherwise technically qualified candidates. Strengthening soft skills training is therefore an essential component of developing a resilient, job-ready regional workforce.

Another key insight from stakeholder engagement was the growing importance of “carbon literacy” among industry professionals. Carbon literacy refers to a foundational understanding of emissions, climate change, and sustainability principles. This need is especially pronounced in industries that compete in global markets,

where a product's carbon footprint can serve as a critical competitive advantage. Yet these topics are not typically included in workforce development programs or in the educational pathways associated with those fields. This gap underscores the broader need to strengthen public understanding of climate science and sustainability to better support an evolving, climate-aware economy.

Workforce Partners and Training Resources

In the medium to long term, creating a support network of partners, educational institutions, training providers, and government agencies will help support career transitions and solutions to Air Quality Plan implementation. Apprenticeships, reskilling opportunities, and flexible certification pathways can help ensure a steady pipeline of qualified workers for Air Quality Plan execution.

Within the Richmond MSA there are a range of training (based out of community colleges or privately organized) and apprentice programs for EV, heat pump, electrical, and HVAC installation and maintenance, construction, energy auditing, farming, landscaping, operating buses and heavy tractor trailers.

Early Career Professional Development

Meeting the demands of a clean energy economy requires introducing high schoolers and young professionals to these career opportunities. Richmond Public Schools, Henrico County Public Schools, Goochland High School, Dinwiddie High School, Powhatan High School, and Sussex Central High School all have career training opportunities that align with the workforce needs identified in this analysis. These career pathways should be strengthened and expanded. It will be crucial to maintain open lines of communication with professional development programs in schools to fill workforce gaps and provide steady jobs to graduates. Connecting high school programs to employers and apprenticeship opportunities is a good strategy for propelling students into the workforce.

Ultimately, addressing workforce shortages and surpluses is central to the success of Air Quality Plan and supporting the Richmond MSA community members. By anticipating labor market trends, investing in workforce development, and embracing innovative workforce solutions, the region can secure the expertise needed for the Air Quality Plan. Adequately evaluating these workforce imbalances is beneficial to ensuring that the Air Quality Plan measures can be implemented but also provides workers with opportunities to develop new skills, pivot careers, and implement vital climate action.

Moving Forward

The Pathways to the Future: Air Quality Plan marks a major milestone for the Richmond region. For the first time, our localities have set forth a common vision for a clean energy future – one built on collaboration, backed by data, and buoyed by a shared commitment to protecting the region's long-term prosperity. Developing this plan has shown what can be achieved when the region comes together to look ahead, and it has laid the groundwork for a coordinated response to the challenges and opportunities of climate change.

PlanRVA's role moving forward is to keep that collaboration alive and to help support localities and our partners in the region as they begin the hard work of implementation. There are real challenges ahead, including limited funding and reduced access to federal data, the region's spirit of cooperation and innovation continues to be one of its greatest strengths. PlanRVA will pursue funding to support the implementation of greenhouse gas reduction measures, identifying opportunities from federal, state, and philanthropic sources. We began this work at the publication of the Priority Climate Action Plan (PCAP) in 2024 by pursuing – and winning – funding to address waste, climate resilience, and natural resource conservation. We will continue to bring resources into the region to advance the strategies outlined in this plan.

Central to this next phase of work are the **Mini-Action Plans** (MAPs) which will guide local implementation. PlanRVA will help localities to create a MAP that aligns with the regional Air Quality Plan but reflects the community's own priorities and capacity. Each MAP will identify a small set of high-impact strategies to focus on over the next two to five years, with clear metrics to track progress and connect each initiative to potential funding sources. PlanRVA will develop a MAP template, user guide, and provide relevant data to support this effort. By helping localities focus on achievable, short-term goals, these MAPs will ensure steady progress while keeping the region aligned around common objectives. They will also set the stage for the 2027 Status Report, which will summarize the region's accomplishments, highlight lessons learned, and point the way forward.

At the same time, PlanRVA will continue leading regional initiatives that advance the plan's broader goals. We will work with the CVTA, VDOT, GRTC, and local governments to strengthen the active transportation network, complete the Fall Line Trail, and improve access to reliable transit – all of which reduce vehicle miles traveled and support cleaner, healthier communities. We will also continue to refine and track the metrics identified in this plan, improving data collection and accessibility to ensure the region can monitor progress with clarity and transparency. These metrics, along with stories of local innovation, will be shared publicly on an expanded project webpage that allows residents to learn about the plan, explore its concepts, and follow the region's progress over time.

PlanRVA also remains committed to delivering on community expectations by seeking outside funding to conduct a benefits analysis of the Air Quality Plan, which was a deliverable requested by residents during the planning process. This analysis will help explore how the economic, social, and environmental advantages and potential pitfalls may be distributed across residents and will provide foresight into understanding the impact of local and regional investments.

Mini Action Plans (MAPs), developed by localities, will move the Air Quality Plan from paper to implementation by identifying high priority initiatives in each community.

Building broad public understanding and support will be essential to achieving the goals of the Air Quality Plan. Across all sectors, general education on climate change, energy efficiency, and sustainable practices was identified as a critical regional need. All partners – localities, agencies, institutions, and community organizations – must remain committed to improving the general public’s understanding of basic climate science and how individual and collective actions contribute to regional progress. Public awareness not only fosters informed decision-making and reduces opposition to sustainable projects but also builds the shared sense of responsibility and participation necessary for the long-term success of the plan.

In 2027, PlanRVA will deliver the Status Report to the U.S. EPA which, as required, will include updated greenhouse gas modeling and a new emissions inventory. PlanRVA will continue to use the best available information to provide a transparent picture of regional progress. Continued monitoring and data analysis beyond 2027 will require new funding, and securing those resources will remain a priority in the years ahead.

The path forward will not be without its challenges, but this plan – and the partnerships it represents – give the region a clear direction and a strong foundation. The Air Quality Plan provides the roadmap, and the MAPs will turn that roadmap into action. Together, the Richmond region can continue to demonstrate how collaboration, creativity, and persistence can drive real climate progress and create a more sustainable future for all who call this region home.