

Appendix E. Methodology for Quantifying GHG Reductions from Implementation Scenario Measures

This appendix outlines the approaches used to quantify GHG emission reductions for the CCAP measures. In some instances, NCDEQ conducted new analysis, and in others already modeled or quantified data was used. There are two measures that are not included in this approach because there were no actionable projects to include in the CCAP; they are VMT (Measure 4) and Industry (Measure 9).

1.1. Sector 1. Transportation Measures 1 - 4

1.1.1. Measure 1: Increase the number of medium- and heavy-duty (MHD) low-carbon emitting and electric vehicles through programs to replace diesel emission vehicles.

Quantified GHG Emission Reduction methods

Methods for calculating emissions for this measure are taken from the Final VW Mitigation Plan Appendix D published in 2018. <https://www.deq.nc.gov/documents/files/vw/nc-final-vw-mitigation-plan-082018/download?attachment>

The VW Mitigation project and data are available on this website:

<https://www.deq.nc.gov/about/divisions/air-quality/motor-vehicles-and-air-quality/volkswagen-settlement/volkswagen-settlement-clean-vehicle-replacements>

The DERA project and data are available on this website:

<https://www.deq.nc.gov/about/divisions/air-quality/motor-vehicles-and-air-quality/mobile-sources-emissions-reductions-grant/past-mobile-sources-emissions-reductions-grants#2024GrantAwards-19587>

The NCDEQ used values from project proposals received during the VW grant proposal timeframe for heavy-duty vehicles or from previously awarded Diesel Emission Reduction Act grant applications for heavy-duty vehicles as inputs into the methods described below. We assume that GHG emission reductions are first realized in 2030 regardless of project start date to account for all projects included in this measure.

The CFAT GHG emission reductions from projects in the 2022 cycle were 3,858.47 short tons (3,500.34 MTCO_{2e}). Projects for the 2025 cycle are in process and GHG emission estimates will be provided in future monitoring reports. These data were supplied by the NC Clean Energy Technology Center (NCCETC) staff. The NCCETC used values from project proposals collected during the grant proposal timeframe as inputs to AFLEET to estimate GHG emissions.

Heavy-duty on-road vehicles

The NCDEQ used the Argonne National Laboratory Heavy-Duty Vehicle Emissions Calculator (HDVEC) to estimate emissions from heavy-duty on-road vehicles. The HDVEC was developed to estimate the vehicle operation nitrogen oxide (NO_x) and particulate matter (PM_{2.5}), as well as the well-to-wheel greenhouse gas emissions (GHGs) of commercially available alternative fuel medium- and heavy-duty vehicles.

The HDVEC Parameters used for estimating emissions for school and transit buses and refuse trucks include:

- Predicted lifetime of vehicle
- Model year of original vehicle
- Annual miles of old vehicle
- Annual miles of new vehicle
- Annual emissions in pounds

Additional parameters included vehicle and fuel type combinations modeled. The NCDEQ used values from preliminary project proposals received during the Request for Information (RFI). The NCDEQ ran the HDVEC for 1 vehicle in each category.

Calculations:

The HDVEC outputs lifetime NO_x emissions reduced in pounds per year. The NCDEQ used the following equations to convert the lifetime emission reductions to short tons per year (Eq. 1) and to calculate the Lifetime Cost Effectiveness (Eq. 2).

$$Eq. 1: \text{Lifetime Emissions Reduced (tpy)} = \frac{\text{Lifetime Emissions reduced } \left(\frac{lb}{yr}\right)}{2000 \text{ lb/ton}}$$

$$Eq. 2: \text{Lifetime Cost Effectiveness } \left(\frac{\$}{\text{ton NOX}}\right) = \frac{\text{Cost in \$}}{\text{Lifetime Emissions Reduced (tons NOX)}}$$

tpy: tons per year
lb/yr: pounds per year

Figure E- 1. Calculations for NO_x emissions reduced

Table E-1. Vehicles Replaced under NC VW Program by type

Vehicle Type	Number Replaced	All-electric*
School buses	271	48

Transit and shuttle buses	64	24
Heavy-duty and equipment vehicles	88	4
Total	423	76

*All-electric replacement account for 86% of GHGs reduced.

The annual emissions of 37,025 MTCO_{2e} remain constant over the lifetime of the project, and cumulative emissions in 2030 and 2050 are 37,024.89 MTCO_{2e} and 687,997.85 MTCO_{2e} respectively.

1.1.2. Measure 2: Identify, install, and maintain a public electric vehicle charging network to support increased EV adoption statewide.

Quantified GHG Emission Reduction methods

NCDEQ utilized Argonne National Laboratory's AFLEET Charging and Fueling Infrastructure (CFI) Emissions Tool. This tool estimates well-to-wheel greenhouse gas emissions and vehicle operation air pollutant emissions for proposals to the Federal Highway Administration's (FHWA) Charging and Fueling Infrastructure Discretionary Grant Program (CFI Program). The CFI Program covers electric vehicle charging, as well as hydrogen, propane, and natural gas fueling infrastructure. This methodology was used to estimate GHG emission reductions for both DC Fast and Level 2 charging stations.

The VW Mitigation project and data are available on this website:

<https://www.deq.nc.gov/about/divisions/air-quality/motor-vehicles-and-air-quality/volkswagen-settlement/volkswagen-settlement-ev-charging-infrastructure>

Calculations:

The NCDEQ modeled lifetime GHG emissions reduced in short tons per year for each project submitted. Lifetime is defined by the 5 year warranty required for each project. We assume that GHG emission reductions are first realized in 2030 regardless of project start date to account for all projects included in this measure. Additional information input into the model are:

- Number of Chargers
- Weekly Utilization (sessions/week/ charger)
- Average Session Power (kW)
- Charge Time (minutes/ session)

The latter three inputs are constants based on the venue where the chargers were installed. Venues included:

- Parking Lot

- Retail & Leisure
- Education
- Healthcare
- Workplace
- Multi-Unit Dwelling
- Single-Unit Dwelling

Total annual avoided emissions for Measure 2 in 2030 and 2050 are held constant 16,524.31 MTCO₂e assuming no additional funding or additional charging station deployment. Cumulative emissions for 2030 and 2050 are 16,524.31 MTCO₂e and 330,486.30 MTCO₂e respectively.

1.1.3. Measure 3: Implement programs to increase efficiency and reduce GHG emissions at deep water and inland ports.

This measure aims to implement programs to improve energy efficiency associated with freight shipping across the State and lower emissions along the State’s critical freight corridors that serve deep water and inland ports. These programs include upgrading technology at freight terminals and ports, expanding more efficient freight corridors across the state, and coordinating with private industry to increase electrification of equipment. GHG emission reductions for current programs are outlined in this section. Additionally, background information about Cost Benefits are described.

GHG reduction calculations approach

3-1. Intermodal Yard Improvements and Shipping Facility

This project accounts for diverting cargo moved by truck to rail. The CO₂ emission reductions calculated for this measure were estimated for 2025-2044 and held constant for 2045-2050. It is estimated that numbers of containers that could be shipped by rail would reach the 50,000 container rail movements per year capacity limit by 2040. Net emission reduction estimates were prepared for each year and summed to develop cumulative estimates for 2025-2030 and 2025-2050.

The incremental avoided CO₂ emissions for trucks was estimated using the total number of containers that could be diverted from trucks (one container per truck) to trains (200 containers/train for Charlotte and 234 containers/train for Rocky Mount) and the mileage from the Port of Wilmington to Charlotte (206 miles one way) or Rocky Mount (169 miles one way). Total truck miles diverted was multiplied by the CO₂ emission factor to estimate emissions. For truck container shipments to Charlotte, emissions were estimated incremental to existing shipments; therefore, container shipments diverted to train would not occur until 2036. The in-land port in Rocky Mount is new; therefore, container shipments diverted to train would start in 2025. The CO₂ emission factor for a heavy truck

(1,646.77 grams CO₂ per mile) was multiplied by the total miles diverted from trucks to trains to estimate avoided CO₂ emissions (see U.S. Environmental Protection Agency, Emission Factors for Greenhouse Gas Inventories, Last Modified March 9, 2018, see Table 2).

The incremental increase in CO₂ emissions for trains was estimated using the total amount of incremental fuel that would be consumed by transporting containers diverted from trucks. The incremental fuel consumption was based on an estimate of the additional rail revenue ton miles using an average weight of the cargo per container (40 tons per train car), transport distance from the Port of Wilmington to Charlotte (206 miles one way) or Rocky Mount (169 miles one way), and number of containers transferred from trucks to trains. The Association of American Railroads reports rail fuel efficiency in 2018 at about 470 ton-miles of cargo hauled per gallon of fuel on average (see Association of American Railroads, The Environmental Benefits of Moving Freight by Rail, July 2019). The inverse of this value (0.00188 gallon per revenue ton mile) was multiplied by total revenue ton miles to estimate total fuel consumption. Total fuel consumed for both routes was then multiplied by a CO₂ emission factor for diesel fuel (10,180 grams CO₂ per gallon) to calculate the incremental increase in CO₂ emissions (see U.S. Environmental Protection Agency, Greenhouse Gases Equivalencies Calculator)

There are many other benefits associated with this measure including a net decrease in PM_{2.5}, NO_x, and SO₂ emissions; travel time savings; and contributions to a decrease in on-road highway congestion, accidents, and fatalities.

3-2. NC Port Container Handler and Drayage Replacement

The project will replace cargo handling equipment with newer, more efficient equipment at the Port of Wilmington. The target fleet type is container handling equipment and terminal drayage trucks. The project will replace two (2) container handlers that are CARB/low NO_x certified, one (1) Class 8 non-DOT certified yard tractor, and three (3) Class 8 DOT Certified with VIN dray terminal trucks in Wilmington.

Emissions were calculated using the Diesel Emission Quantifier model for (5) container handlers and (4) yard tractors for the funding application; however, only (2) container handlers and (1) yard truck were funded. The total emissions reduced for lifetime of project were estimated to be 2,509 short tons CO₂. This estimate was divided by 3 to reflect the actual emissions and converted to MTCO_{2e}. Emissions related to idling from the (3) dray terminal trucks were not calculated because no information on the Port's current equipment operations and idle times was available and requires an idle-reduction policy to be put in place.

3-3 Pedestrian Safety Rail Bridge

The project will construct (1) an off-terminal parking facility for more than 250 employees and port users and (2) a pedestrian rail bridge (spanning six port railroad tracks) reducing GHG emissions by reducing VMT and also improving safety for employees and visitors.

Emissions were calculated using the EPA MOVES3.1 model emission factors for 2021, 2024 and 2027. VMT was estimated using annual average daily traffic counts and average miles traveled; 116 trips and 0.7miles respectively. The total emissions reduced is assumed constant over time because the project will be complete in 2027 and the number of vehicles in the offsite parking location will remain constant given the spaces allocated.

3-4 Modernization & Revitalization of Barge Berths

This project will rebuild the barge berths at the Port of Morehead City. GHG emission reductions were calculated for 2 different scenarios where either trucks or rail were used to haul the cargo in lieu of barge. The incremental avoided CO₂ emissions for trucks was estimated using the average VMT for trucks multiplied by the emission factor (1646.77 g CO₂/mile) and then converting to MT. The incremental avoid CO₂ emissions for rail was estimated using the VMT multiplied by the emission factor (10180 g/gallon diesel) and then converting to MT. The CO₂ emissions from the barge were removed from the total estimate. The total emissions reduced is assumed constant over time because no additional barges can be accommodated in this port.

Total annual avoided emissions for Measure 3 in 2030 and 2050 are 11,447.76 MTCO_{2e} and 18,077.47 MTCO_{2e}, respectively assuming no additional projects related to NC ports.

Measure Costs

Each sub-measure estimated costs for implementation differently, therefore all sub-measure estimations are included below.

1. Intermodal Yard Improvements and Shipping Facility | A quantitative benefit-cost analysis (BCA)¹ was performed using available information about current truck drayage practices and current and proposed train operations, USDOT guidance, and supported by documentable costs and industry research data. The BCA is not a comprehensive measure of the project's total potential economic impact as regional benefits related to changes to the financial and workforce were not included. Future years' costs and benefits were projected, in constant dollars, for a period extending 20 years beyond construction which is approximately 2044.

Table E-2. Benefit Cost Summary (reproduced from Table 5 in the report)

Benefit or Cost Category		
Tot. Capital Cost including match @ 7% NPV		\$18,184,207
Quantified Benefits @7% NPV:		
	Accident Reduction	\$6,606,246
	Non-Carbon Emissions Reduction	\$3,075,711
	Fuel Cost Savings	\$8,235,014
	Social Cost of Carbon @3%	\$5,296,877
Additional Savings:		
	Road Wear Savings	\$5,589,267
	Reduced Highway Congestion	\$26,183,412
	Consumer Transport Cost Reduction	\$40,389,306
	Increased Inventory Holding Cost	(\$8,834,992)
Total Quantified Benefits		\$86,540,843
Benefit to Cost Ratio (BCR)		4.8

2. Container Handler and Drayage Replacement | The primary costs for this sub-measure are for the purchase of 3 class 8 dray trucks and scrap disposal; purchase of one class 8 dray truck not DOT certified and scrap disposal; purchase of 2 container handlers and scrap disposal. The NC Port Authority is prepared to provide long-term operations and maintenance costs for these vehicles for their lifetime; however, those costs were not included in the documentation.

3. Pedestrian Safety Rail Bridge | A crucial element, the pedestrian rail bridge, will safely transport personnel across six active rail tracks, eliminating the risk of pedestrian-rail incidents. The primary costs for this sub-measure are for the construction of the pedestrian bridge; however, additional capital costs for this sub-measure include a dedicated shuttle service, pervious parking surfaces, solar panels to power the shuttle system and lighting. Benefits include reduction in VMT and mortality. The lifetime analysis corresponds to a 20-year benefit period until 2049.

Table E-3. Improved Benefits Summary (reproduced from Table 1 in the report^a)

Problems to be addressed	Changes to baseline	Type of Impact	Economic Benefit	Summary of results (\$) ^a
Pedestrian facilities/bridge along project corridor lack dedication protection	Adding a secure and direct path into the port that allows workers to avoid queueing delays	VMT reduction/Idle time reductions	Pavement maintenance avoidance	26, 858
			Emissions costs savings	261,735
			Mortality reduction	17,041,557
			Noise reduction	38,945
		Longterm/Residual value	Facility improvement	329,541

^a discounted at 3.1%

4. Modernization & Revitalization of Barge Berths | The Benefit-Cost Analysis (BCA) for this project included three scenarios. The tables below describe the BCA for costs avoided for (1) diversion of dry cargo to both truck and rail and (2) diversion of dry cargo to truck only. These costs would be realized if the barge berths are not constructed.

Table E-4. Summary BCA Results – Truck and Rail Diversion of Dry Cargo (2022 dollars) – reproduced

Present Value	
Discounted Benefits	
Liquid Barge Depreciation Savings	\$ 3,796,212
Avoided Vessel Congestion	\$ 1,599,454
Liquid Barge Berth Cost Savings	\$ 1,350,073
Liquid Cargo Supply Chain Savings	\$ 243,590
Personnel Time Savings	\$ 14,506,079
Truck/Freight Train Operating	\$ 6,868,827

Safety Benefits	\$ 508,408
Avoided External Highway Use	\$ 6,167,010
Avoided Emissions	\$ 20,278,922
Dry Barge Berth O&M Costs	(\$ 487,181)
Residual Value	\$ 5,282,749
Total Discounted Benefits	\$ 61,309,302
Discounted Costs	
Build Capital Costs	\$ 17,450,878
Total Discounted Costs	\$ 17,450,878
Benefit-Cost Ratio	3.53
Net Present Value	\$ 44,069,645

Table E-5. Summary BCA Results – Truck Diversion of Dry Cargo (2022 dollars) – reproduced

Present Value	
Discounted Benefits	
Liquid Barge Depreciation Savings	\$ 3,796,212
Avoided Vessel Congestion	\$ 1,599,454
Liquid Barge Berth Cost Savings	\$ 1,350,073
Liquid Cargo Supply Chain Savings	\$ 243,590
Personnel Time Savings	\$ 16,622,240
Truck/Freight Train Operating Costs	\$ 5,509,723
Safety Benefits	\$ 521,861

Avoided External Highway Use	\$ 6,740,686
Avoided Emissions	\$ 7,042,745
Dry Barge Berth O&M Costs	(\$ 487,181)
Residual Value	\$ 5,282,749
Total Discounted Benefits	\$ 49,528,488
Discounted Costs	
Build Capital Costs	\$ 17,450,878
Total Discounted Costs	\$ 17,450,878
Benefit-Cost Ratio	2.84
Net Present Value	\$ 32,077,610

1.1.4. Measure 4: VMT – Unfunded

There are no projects or emissions calculated for the CCAP under this measure

1.2. Sector 2. Electricity Generation Measures 5 and 6

1.2.1. Measure 5: Increase the amount of electricity generated by distributed and renewable resources in NC.

5-1 EnergizeNC

For the EnergizeNC calculation an assumed 43,400 kW of residential solar will be installed, as this is the lower bound of the program. This value was entered into NREL’s PVWatts calculator for an estimated 60,372,493 kWh/year, the lifetime of the panels is assumed to be 25 years, resulting in a total of 1,509,312,325 kWh. To derive the amount of MTCO_{2e}, EPA’s eGrid Emission Factor of 0.000303907 MTCO_{2e}/kWh was used. This resulted in 18,347.62 MTCO_{2e}/year. Projecting GHG emission reductions for 2030 and 2050 result in 91,738.12 and 458,690.58 MTCO_{2e} respectively. The emission factor provided in the model may not accurately reflect changes in electricity distribution for NC because it is an average of electricity generation plant data in the southeast region. Additionally, future emission reductions will vary as grid investments and the power profile changes.

5-2 Geothermal

The calculations and methods for this measure are included in Sector 3 – Commercial and Residential Buildings – Measure 8.

5-3 Timbermill Wind, LLC

At the current rate, Timbermill Wind is displacing 273,788.32 MTCO_{2e} annually. This calculation was derived from using the EPA AVERT tool (<http://www.epa.gov/avert/download-avert>) with the mid-Atlantic region data file assuming a 189 MW energy generating capacity from 45 wind turbines. Projecting GHG emission reductions through 2030 and 2050 result in 1,368,941.71 and 6,844,708.56 MTCO_{2e} respectively.

1.2.2. Measure 6: Implement measures to increase energy resiliency in NC communities: [Microgrids for North Carolina Resilience](#)

The microgrid calculation is based on estimates developed for the project application.

Table E-6. Number of Solar Units per kW PV for Microgrid

Number of units	kW Solar PV	Total kW	kWh LFP storage	Ave kWh LFP storage
5	20	100	10 - 50	30
20	50	1,000	50 - 100	75
50	100	5,000	50 - 200	125
2 (beehive)	5	10	n/a	n/a
Totals		6,110		230

The project estimated 6,100 kW solar PV with 110 kWh LFP storage and an additional 10 kW PV solar for the beehive system to be installed. NREL’s PVWatts Calculator was used to estimate a total annual production of 8,658,477 kWh/year. The lifetime of the system was assumed to last 25 years, and the first year GHG emissions were reduced was 2025. To derive the amount of MTCO_{2e}, EPA’s eGrid Emission Factor of 0.000303907 MTCO_{2e}/kWh was used. This results in 2,631.37 MTCO_{2e} annually and 65,784.29 MTCO_{2e} over 25 years. The emission factor provided in the model may not accurately reflect changes in electricity distribution for NC because it is an average of electricity generation plant data in the southeast region. Additionally, future emission reductions will vary as grid investments and the power profile changes.

1.3. Sector 3. Buildings - Residential and Commercial Measures 7 and 8

1.3.1. Measure 7: Reduce per square foot energy usage in residential buildings in NC

Overview

For each program in Measure 7, energy savings were estimated using available program data, regional building stock characteristics, and assumptions related to equipment lifetime and performance. Estimated energy savings were then converted into avoided GHG emissions using emissions factors shown in Table E-6. Total annual avoided emissions for Measure 7 in 2030 and 2050 are 25,649 MTCO₂e and 22,895 MTCO₂e, respectively. Cumulative avoided emissions for Measure 7 by 2030 and by 2050 are 90,876 MTCO₂e and 736,196 MTCO₂e, respectively.

Table E-7. GHG Emission Factors

Energy Source	Emission Factor	Units	Data Source
Electricity^a	0.3039	MTCO ₂ e/MWh	NCDEQ (eGRID)
Natural Gas	53.115	kg CO ₂ e/MMBtu	EPA GHG Emission Factors Hub (2025)
Propane	61.703	kg CO ₂ e/MMBtu	
Fuel Oil No. 2	74.203	kg CO ₂ e/MMBtu	

^a The eGRID emission factor provided by NCDEQ was applied to all years from 2025 to 2050.

Key components of the methodology and assumptions are described below.

Methodology

Program Rollout and Lifetime Assumptions

WAP measures were assumed to reach 1,945 homes per year from 2025 through 2050, based on the historical average of annual completions. An additional 600 homes per year were modeled under the WAP program from 2025-2029, reflecting funding through the Bipartisan Infrastructure Law (BIL). Measures funded through the HOMES and HEAR programs were assumed to be rolled out evenly over the period from 2025 to 2031. For all programs, installed measures were assumed to have a 15-year effective savings lifetime, with savings rolling off after this time period.

Whole-Home and Weatherization Measures

Applies to WAP, HOMES, and HEAR rebates for insulation, air sealing, and ventilation upgrades.

NCDEQ's contractor, ICF, derived statewide averages for annual North Carolina household energy consumption by fuel type using statewide averages from EIA's Residential Energy Consumption Survey (RECS), Table CE2.1.ST. Energy savings were then estimated as a percentage reduction in total household energy use based on program/market estimates and applied uniformly across fuels, including electricity, natural gas, and propane. These savings were subsequently converted to GHG emissions reductions using the emissions factors listed in Table 1.

Appliance-Level Measures

Applies to HEAR rebates for heat pumps, heat pump water heaters, heat pump clothes dryers/washers, and electric ranges/stovetops.

ICF derived statewide averages for annual household energy consumption by fuel type and end-use using RECS microdata. For each end-use listed in Table E-7, baseline equipment distributions in North Carolina's residential building stock were estimated using NREL's ResStock 2024.2 dataset.

NCDEQ provided assumptions regarding the total number of rebates available for each project type (Table E-8). These rebates were then allocated proportionally according to the baseline distribution of existing technologies. For instance, 18% of NC water heating systems in the baseline stock are gas-fired, 77% are electric resistance, and 4% are propane-fired. It is assumed then that 18% of rebates for heat pump water heaters would replace gas units, 77% would replace electric units, and 4% would replace propane units.

Table E-8. Distribution of Baseline Equipment by End Use and Fuel

End Use	Natural Gas	Electric	Propane	Fuel Oil
Space Heating	22%	23% ^a	7%	3%
Cooling	N/A	100%	N/A	N/A
Water Heating	18%	77% ^a	4%	N/A
Clothes Dryer	2%	85% ^a	1%	N/A
Cooking	14%	81%	6%	N/A

^a Baseline equipment is electric resistance, reflecting with program requirements.

Note: Remaining space heating equipment is comprised primarily of heat pump technologies

Table E-9. Distribution of HEAR Rebates by Baseline Equipment

End Use	Project Type	Total Rebates	Rebates by Baseline Equipment			
			Gas	Electric	Propane	Fuel Oil
Space Heating	Heat pump for space	5,742	2,294	2,391 ^a	746	311
Cooling	heating/cooling	5,742 ^b	N/A	5,742	N/A	N/A
Water Heating	Heat pump water heater	6,294	1,159	4,903 ^a	232	N/A
Clothes Dryer	Heat pump dryer	3,520	93	3,392	35	N/A
Cooking	Electric stove	1,482	1,047	N/A ^c	435	N/A

^a Baseline equipment is electric resistance.

^b According to EIA RECS, 91% of homes in NC have existing AC systems. ICF therefore assumes that 91% of homes receiving heat pump rebates will see energy savings from improved cooling efficiency. The remaining 9% are assumed to add new cooling load, leading to increased electricity consumption.

^c Rebates are not available for electric-to-electric conversions.

Measure-specific energy savings (e.g., gas water heater to heat pump water heater) were estimated using a combination of sources, including NREL’s Residential Measures Database, EIA’s 2023 Technology Forecast Updates, and a review of available literature. These savings were multiplied by the number of projected upgrades listed in Table 3 to calculate total energy savings by fuel and project type. Energy savings were subsequently converted to GHG emissions reductions using the emissions factors listed in Table E-7. Note that upgrades related to wiring and electric load service centers were excluded from the analysis, as their impact on energy consumption is indirect and not quantifiable in terms of GHG reductions.

Program-Specific Assumptions

Weatherization Assistance Program (WAP)	
Program Description	WAP provides weatherization services (e.g., insulation, air sealing, ventilation) to low-income households, funded through the U.S. Department of Energy (DOE) and the North Carolina Department of Health and Human Services (DHHS).
Program Participation	1,945 homes upgraded annually from 2025 through 2050, based on average completions between 2020 and 2024. An additional 600 homes are also modeled as upgraded annually from 2025-2029 through one-time funding from the BIL.
Total Homes Upgraded	53,570
Rollout Period	2025-2050
Savings Assumption(s)	15% reduction in total household energy consumption per home, applied proportionally across fuels. This value is based on national WAP statistics, which show typical savings ranging from 7-18%. ¹

Homeowners Managing Efficiency Savings (HOMES)	
Program Description	HOMES provides rebates for whole-home energy efficiency improvements. A total of \$68 million is allocated to direct rebates, with a maximum rebate of \$16,000 per household.
Program Participation	4,250 total homes upgraded statewide, evenly distributed across the years 2025–2031.
Total Rebates Provided	4,250
Rollout Period	2025-2031
Savings Assumption(s)	20% reduction in total household energy use per upgraded home, applied proportionally across fuels. This aligns with the minimum program requirement.

¹ U.S. DOE (2015). *National Evaluation of the Weatherization Assistance Program*.

https://www.energy.gov/sites/prod/files/2015/08/f25/WAP_NationalEvaluation_WxWorks_v14_blue_8%205%2015.pdf

Home Electrification and Appliance Rebates (HEAR)	
Program Description	HEAR provides \$74 million in rebates for energy-efficient electric appliances and related upgrades.
Program Participation	Rebate counts by project type were estimated based on assumptions provided by NCDEQ. Rebate deployment was assumed to be evenly distributed across the years 2025–2031.
Total Rebates Provided	23,332 ^a
Rollout Period	2025-2031
Savings Assumption(s)	Measure-specific energy savings were estimated using a combination of sources, including NREL's Residential Measures Database, EIA's Technology Forecast Updates, and a review of available literature.

^a Excludes rebates for electric load service centers and electric wiring.

1.3.2. Measure 8: Decarbonize buildings in NC, through replacement of fossil fuel combustion and other GHG emission sources

Measure 8 reflects savings under North Carolina's Utility Savings Initiative (USI), which targets energy reduction in state agencies and institutions. Total annual avoided emissions for Measure 8 compared to the BAU in 2030 and 2050 are 156,141 MTCO_{2e} and 195,320 MTCO_{2e}, respectively. Cumulative avoided emissions for Measure 8 by 2030 and by 2050 are 577,632 MTCO_{2e} and 4,465,162 MTCO_{2e}, respectively.

To calculate avoided emissions resulting from the USI, the following methodology was applied. Since the program's inception in 2001, most state agencies have reported annual energy consumption and building square footage. By 2005, reporting expanded to include University of North Carolina (UNC) institutions and the North Carolina Community College System. Using this data, the USI calculates annual Energy Use Intensity (EUI) using the formula:

$$EUI = \text{Total Energy Use (BTUs)} / \text{Total Square Footage}$$

For each reported fuel type — electricity (kWh), natural gas (therms), No. 2 oil (gallons), No. 6 oil (gallons), and propane (gallons) — a fuel-specific Energy Intensity (EI) was also calculated:

$$EI = \text{Fuel Use} / \text{Square Footage}$$

These historical EI values were plotted over time, and future EI values for each fuel type were extrapolated annually through 2031-2032 based on a linear regression of the

historical values, after which they were held constant through 2050. Projected fuel use was then back-calculated using these EI values and the assumed square footage. For forecasting purposes, square footage was held constant at the 2023-2024 levels throughout the projection period.

Next, greenhouse gas (GHG) emissions were estimated using published emissions coefficients for each fuel type. In the case of electricity, annual coefficients were held at 2023-2024 levels, reflecting a conservative savings estimate which is expected to increase with higher levels of grid decarbonization in North Carolina. To align with CPRG (Climate Pollution Reduction Grant) guidelines, the 2023-2024 baseline year (the most recent available year with data) was used to ensure consistency with Business-As-Usual (BAU) projections. Emissions were calculated for each fuel type as follows:

$$\text{Actual Emissions} = \text{Fuel Use} \times \text{Emissions Coefficient (by year/fuel type)}$$

$$\text{Baseline Emissions (2023-2024)} = \text{Fuel Use (2023-2024)} \times \text{Emissions Coefficient (2023-2024)}$$

$$\text{Avoided Emissions} = \text{Baseline Emissions} - \text{Actual Emissions}$$

Finally, avoided emissions across all fuel types were summed to determine total avoided emissions attributable to the USI program annually.

1.4. Sector 4. Industry Measure 9

1.4.1. Measure 9: Industrial Decarbonization Planning and Opportunity Analysis (Unfunded).

There are no projects or emissions calculated for the CCAP under this measure.

1.5. Sector 5. Waste Measures 10 - 12

1.5.1. Measure 10: Reduce food waste entering the waste management system to reduce the methane emissions from food waste landfilling, direct food to communities in need, and create organic resources through composting.

Avoided emissions from food diversion programs were calculated from data collected through research of existing food collection programs, surveys, and interviews of experts in the waste industry. There are 24 locations in the state that collect food through composting or recovery programs at schools, cities and counties. The GHG reduction was determined based on a weight basis (tons/year) using EPA's Waste Reduction Model (WARM).

Data were collected for compost and recovery programs, resulting in 23,162.21 6 short tons and 336,393.53 42 short tons, respectively. Using WARM EFs for compost and recovery

(0.15 MTCO₂e/short ton and 3.66 MTCO₂e/short ton) the GHG reduction goal for this measure is 30,866,865.82 MTCO₂e in 2050.

1.5.2. Measure 11: Decarbonize waste collection to reduce GHG emissions during the collection and transport of wastes through electrification of fleets or through engine conversion from diesel to electric motors.

The calculation of GHG emission reductions for this measure are included in the Transportation Sector Measure 1. Please refer to that section for methodologies.

1.5.3. Measure 12: Reduce landfill gas emissions through improved landfill operations to collect gas more efficiently and earlier in a landfill life

It is estimated that GHG reduction benefits may be on the order of 300 to 600 tons per year of CO₂e, per acre of transitional cover installed, over a 10-year period (4,500 tons/acre). Considering the decrease in the landfill gas over time, the annual GHGs reductions were calculated to be 4,500 tons/acre to account for field conditions. The use of more robust covers prior to closure at multiple landfills across NC has a total application of 200 acres over 25 years.

NCDEQ identified candidate landfills that had potential to reduce methane emissions and an interest in installing systems to do so. NCDEQ selected New Hanover County Landfill, Anson County Landfill, and Surry County Landfill for this modeling. Next, NCDEQ used EPA's Greenhouse Gas Reporting Program (GHGRP) Facility-Level Information on Greenhouse Gases (FLIGHT) Tool to gather methane emissions data for each landfill. With the baseline data in hand, NCDEQ projected a business-as-usual (BAU) scenario for methane emissions at these landfills from 2030 through 2050 using a population growth factor to estimate future emissions. After establishing the projections, NCDEQ made an assumption about the improvement in methane collection efficiency likely to result from installing transitional covers. According to research, such upgrades can enhance collection efficiency by approximately 15%.² Finally, NCDEQ applied this percentage improvement starting in 2030, the year when installation of these systems could realistically begin. In 2030, emissions reductions were estimated to be 36,453. Annual emissions reductions increase slightly year-after-year through 2045 based on assumed population growth. Additionally, the Surry County Landfill ceases operations after 2045, so annual emissions reductions from 2046-2050 do not include emissions reductions from Surry County.

² https://www.scsengineers.com/wp-content/uploads/2015/03/Sullivan_SWICS_White_Paper_Version_2.2_Final.pdf

1.6. Sector 6. Natural and Working Lands Measures 13 and 14

This section summarizes methodologies and estimates for greenhouse gas benefits from natural climate solutions in coastal and forestry projects. The entire Technical Appendix is not included here and refers to the ACC grant application, which refers to all ACC projects, including those in NC, MD, VA, and SC. The GHG benefit estimates included in the NWL part of the CCAP are for the NC projects, and the methodology below was used to calculate those estimates.

1.6.1. Measure 13: Coastal Habitat Enhancement and Peatlands Restoration

GHG benefits from coastal habitat peatlands are estimated based on proposed project area and per-acre GHG benefits from scientific literature. Implementation assumptions vary by geography and project type, with a primary assumption that projects will stay within budget. Additionally, coastal marshes have carbon stocks of 298.30 - 415.11 MTCO₂e/acre, with ongoing benefits of 1.55 - 4.23 MTCO₂e/acre/year. The average annual carbon benefit of this measure was estimated by dividing the total carbon benefit for this measure by the number of years over which this benefit accrues. The annual carbon benefit is estimated to be 468,107.9 MTCO₂e/year for the period 2025 - 2030 and 768,635.3 MTCO₂e/year for the period 2025 - 2050. Total carbon benefit is estimated at 2,340,539.4 MTCO₂e from 2025 - 2030 and 19,215,883.2 MTCO₂e from 2025 - 2050.

1.6.2. Measure 14: Protect, use, and develop agricultural and forest land

GHG benefits from forestry projects are categorized into improved forest management, reforestation, urban tree planting, and avoided forest conversion. Per-acre estimates for GHG benefits are calculated using various data models and methodologies specific to each project type. The primary activity data used to track progress across project types include acres conserved, acres reforested, and number of trees planted. The annual carbon benefit was estimated by dividing the total carbon benefit for this measure by the number of years over which this benefit accrues. Total carbon benefit is estimated at 1,021,710.0 MTCO₂e from 2025 - 2030 and 8,811,294.8 MTCO₂e from 2025 - 2050.