# North Carolina Deep Decarbonization Pathways Analysis

## Public Engagement Session #1

August 11th, 2022

Office of Governor Roy Cooper

Energy+Environmental Economics

# Agenda

- **Welcome and Introduction for the NC Deep Decarbonization Pathways Analysis – Office of Governor Roy Cooper (15 mins)**
  - EO 246
  - Vision + Objectives
- **E3 Background and Project Overview – E3 (45 mins)**
  - Background on Project
  - Project Scope and Timeline
  - Overview of Modeling Approach
  - Benchmarking and Draft Reference Scenario Results
  - Scenario Design
- **Public Input and Next Steps (30 mins)**
  - Feedback + Q&A
  - Next Steps

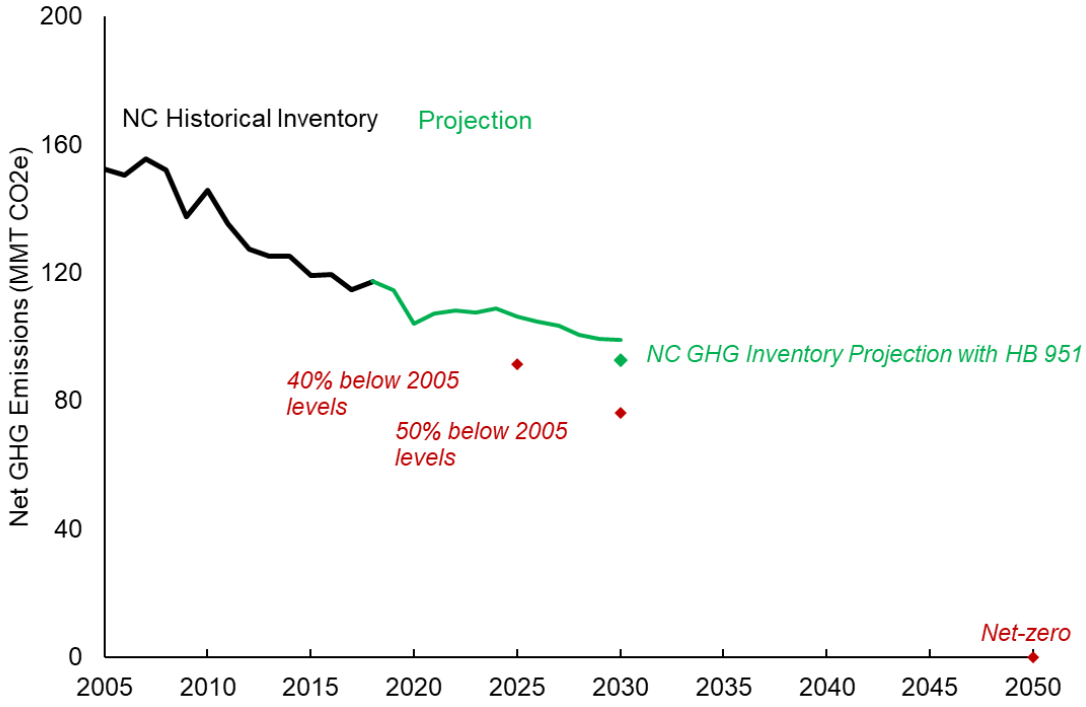
# Climate Action in North Carolina

- **Executive Order No. 246 signed by Governor Cooper in January 2022.**
- **Establishes new statewide goals to:**
  - Reduce statewide greenhouse gas (GHG) emissions at least 50% below 2005 levels by 2030 and achieve net-zero GHG emissions as soon as possible and no later than 2050; and
  - Increase registered zero-emission vehicles (ZEVs) to at least 1,250,000 by 2030 and increase the sale of ZEVs so that 50% of in-state sales of new vehicles are zero-emission by 2030.
- **Directs numerous actions to achieve goals in a manner that centers environmental justice and maximizes public health and economic benefits for all North Carolinians.**

# NC PATHWAYS Vision + Objectives

- **EO 246 directs the development of a North Carolina Deep Decarbonization Pathways Analysis ("Pathways Analysis") that evaluates potential emission-reduction pathways to achieve these goals**
- **Project Goals**
  - Analyze various technologically feasible GHG emissions reduction pathways to achieve economy-wide 2025, 2030 and 2050 GHG targets.
  - Identify high-level policy and planning takeaways that will inform near-term, mid-term and long-term decarbonization efforts.
  - Equip policymakers and stakeholders with a better understanding of how to effectively reduce emissions across the economy and within specific sectors, building on extensive policy efforts underway and creating synergies with existing initiatives.

## North Carolina Net Greenhouse Gas Emissions




Projection based on the 2022 NC GHG Inventory, developed using combination of EPA's Projections Tool module within State Inventory Tool and sector-specific data sources (e.g. MVOES for transportation, Duke forecasts) and incorporate the impact of HB 951

# Background on Project

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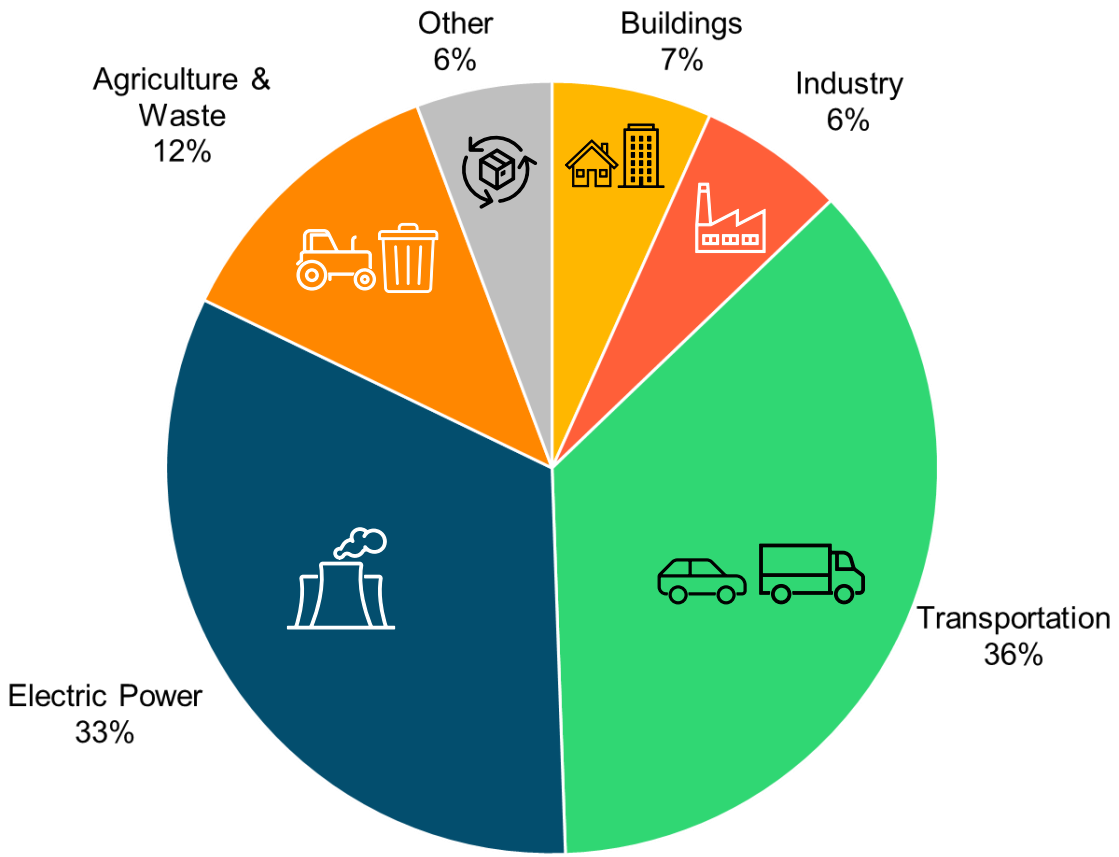
# 2018 Greenhouse Gas (GHG) Emissions by Sector

## North Carolina Gross GHG Emissions Profile




Note: Emissions profile is based on the latest 2022 NC State GHG Inventory. All GHG emissions associated with consumption of electricity in buildings, industry, and transport are accounted for in the “Electric Power” category

## Ongoing Sector-focused Initiatives in NC

- **Clean Transportation Plan**
- **Carbon Plan under the requirement of House Bill 951, NC Clean Energy Plan**
- **Building Code updates**
- **Natural and Working Lands Action Plan**
- **Disbursement of applicable state and federal funding**

# Project Scope and Timeline

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# Project Scope

## + Goals

- An analysis of various technologically feasible GHG emissions reduction pathways to achieve NC's economy-wide 2030 and 2050 GHG targets (50 by 2030 and net-zero by 2050)
- Identify high-level policy and planning takeaways

## + Key Tasks and Timeline

| # | Task | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Project Kickoff and Scenario Scoping | | | | | | | | | |
| 2 | Decarbonization Pathways Scenario Analysis | | | | | | | | | |
| 3 | Stakeholder Engagement | | | | | | | | | |
| 4 | Final Report | | | | | | | | | |

# Stakeholder Engagement

| | External Engagement | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Interagency Steering Committee Meetings | | | | | | | | | |
| 2 | Technical Advisory Group (TAG) Meetings | | | | | | | | | |
| 3 | Targeted Stakeholder Outreach | | | | | | | | | |
| 4 | General Public Engagement Meetings | | | | Aug 11 | | TBD | | TBD | |

# Planned and Proposed Public Engagement Sessions

| | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|
| **Planned and Proposed Public Engagement Sessions** |  | |  | |  | |

+ **Public Engagement Session #1 (Today):** Introducing the pathways analysis scope, process and scenario design and soliciting public feedback

+ **Public Engagement Session #2 (TBD in Oct):** Presenting draft scenario results and soliciting public feedback

+ **Public Engagement Session #3 (TBD in Dec):** Presenting updated final scenario results and soliciting public feedback

# Overview of Modeling Approach

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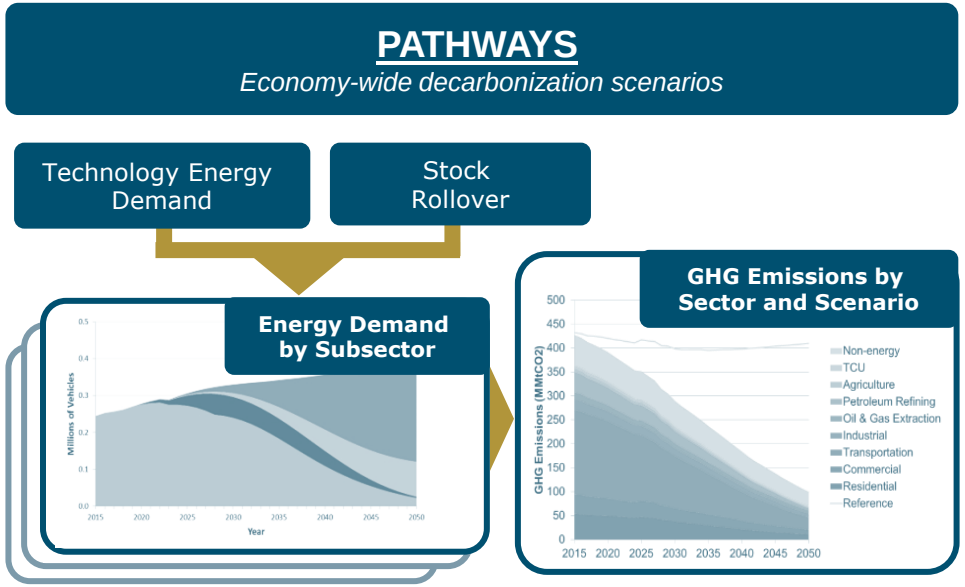
# PATHWAYS Modeling Approach

## + Economy-wide infrastructure-based GHG and energy analysis

- Captures the retirement and replacement of key infrastructure including building appliances and on-road vehicles
- Models physical energy flows within all sectors of the economy
- Allows for rapid comparison between user-defined scenarios

## + Scenarios test "what if" questions

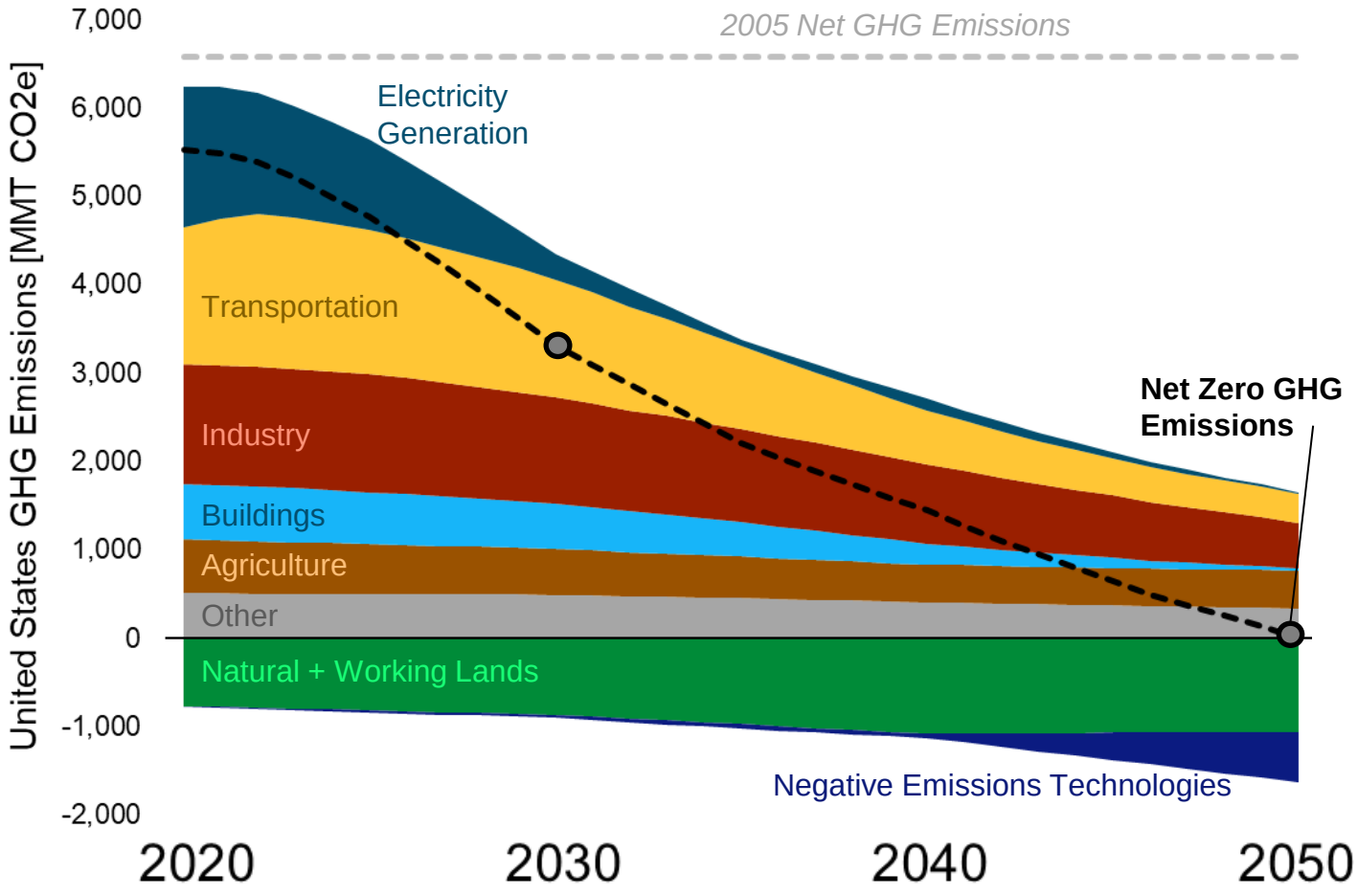
- Reference or counterfactual scenario for consistent comparison in future years
- Multiple mitigation scenarios can be compared that each meet the same GHG emissions goal



# Why PATHWAYS?

## + PATHWAYS can help answer the following questions:

- Where are GHG emissions headed under current policies?
- What is the gap between current policies and GHG targets?
- What are the measures and actions that could help close the gap?
- What is the role of each sector (e.g. transportation, buildings, electricity) in reaching net zero?
- What is the pace of transition needed for customers in terms of building appliances and personal vehicles?
- What is the role of negative emissions such as natural land sinks?
- What are tradeoffs among pathways for achieving net zero?




E3 PATHWAYS analysis conducted for World Resources Institute. Results shown above are Scenario 3

# Benchmarking and Draft Reference Scenario Results

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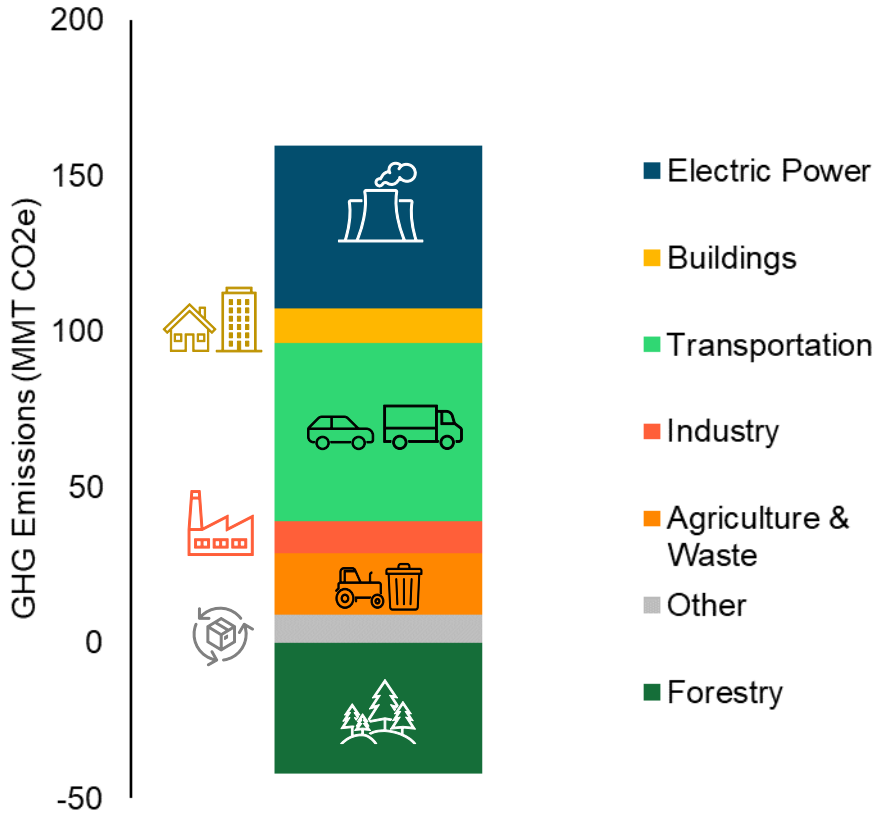
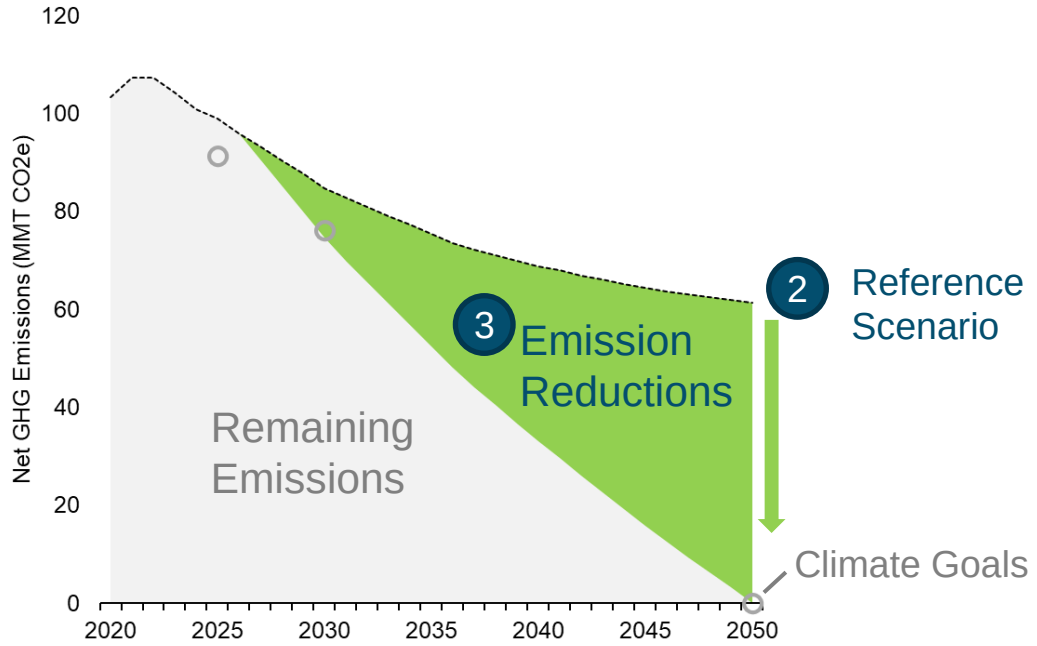
# Steps of a PATHWAYS study

## 1 Measure current greenhouse gas emissions in North Carolina




## 2 Estimate future emissions based on current trends and existing policies



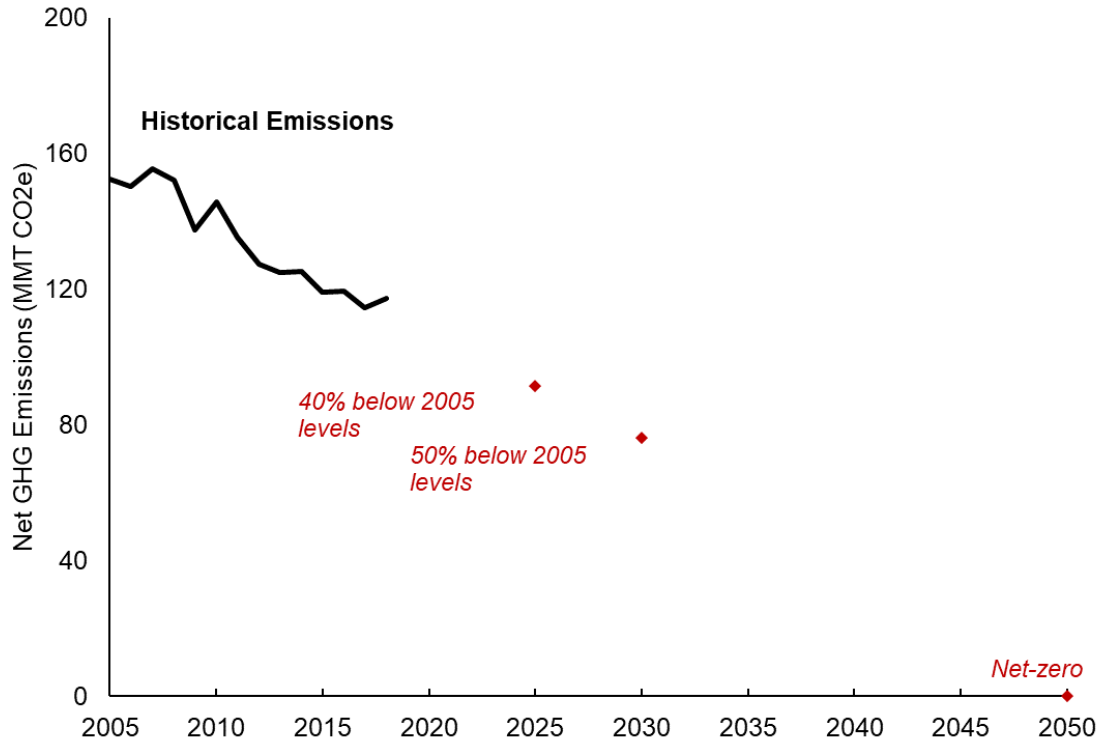

## 3 Evaluate impact of new potential measures and actions that would help the state meet climate goals

Current emissions profile based on the latest 2022 NC State Greenhouse Gas Inventory

# Scenarios test “what if” questions

+ **Types of Scenarios**
  - **Reference Scenario**
    - Business as usual scenario with existing policies and actions included (e.g. population growth rates, federal fuel economy and appliance standards)
  - **Mitigation Scenarios**
    - Comprehensive perspectives of paths to reach mid-term and long-term climate targets
  - **Sensitivities**
    - Often used to test the impact of discrete assumptions (e.g. role of federal fuel economy standards, role of energy efficiency measures, uncertainty in NWL)
+ **E3 has been working with the Governor’s Office, Interagency State Team and the Technical Advisory Group on scenario scoping**

**North Carolina Net Greenhouse Gas Emissions**



# Reference Scenario Overview

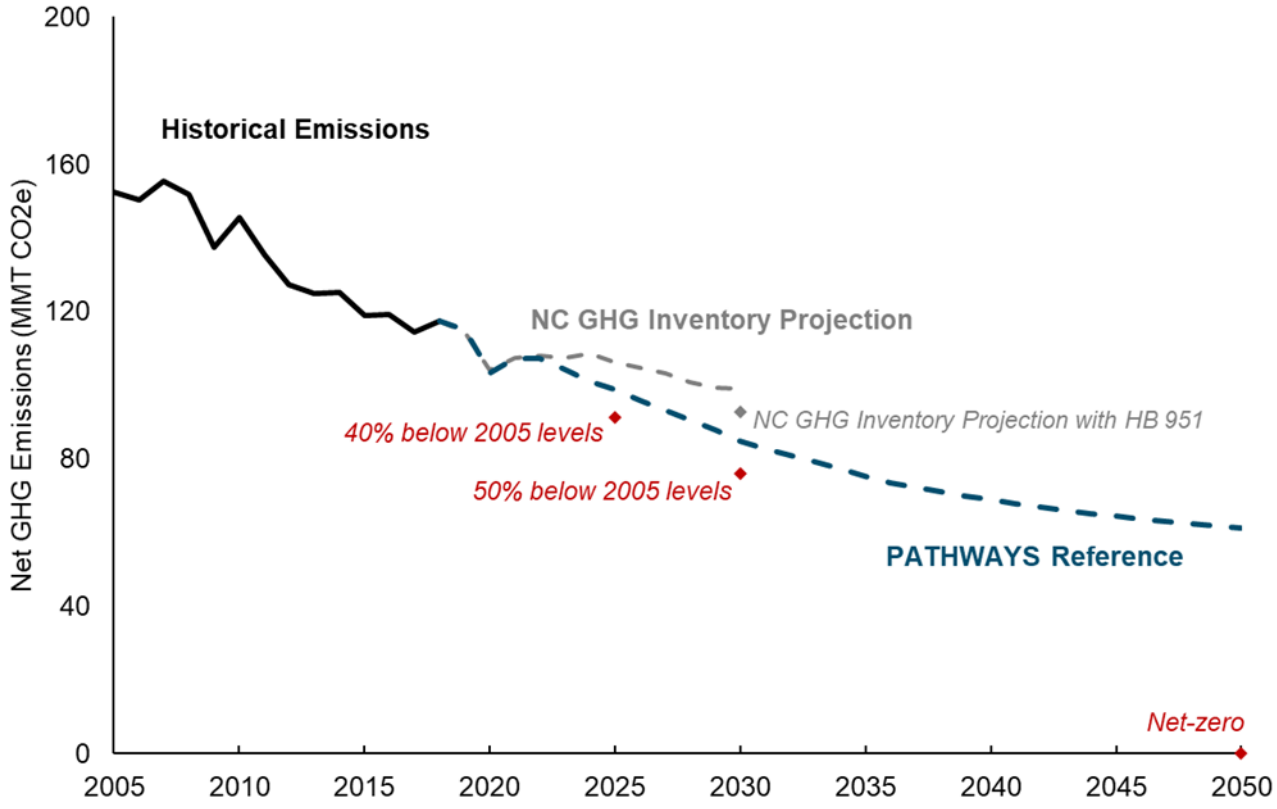
- **Reference scenario is designed to represent a "business-as-usual" view of the future that incorporates existing state and federal policies and current technology trends**

- **Major policies included:**
  - **House Bill (HB) 951**
    - 70% reduction in electricity generation carbon dioxide emissions from in-state generation by large utilities by 2030, net zero emissions by 2050
  - **Federal Corporate Average Fuel Economy (CAFE) standards**
    - Recently announced fuel economy standards for passenger cars and light trucks in model years 2024-2026
  - **Federal Hydrofluorocarbon (HFC) phasedown**
    - Recently finalized EPA regulation of HFC, authorized under American Innovation and Manufacturing (AIM) Act
    - HFC is a widely-used substitute for ozone-depleting substances as refrigerants, but a highly-potent greenhouse gas

- **Impact of the Inflation Reduction Act will be considered if signed into law**

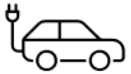
# Reference Scenario Draft Results: Net GHG Emissions

- **The NC PATHWAYS model is benchmarked to the latest NC State GHG Inventory for the 2018 base year**
- **Net GHG emissions in PATHWAYS Reference Scenario decline through mid-century**
- **Reductions below 2005 by year:**
  - 2025: 35%
  - 2030: 44%
  - 2050: 60%
- **Emissions are lower in the PATHWAYS scenario than in the NC GHG Inventory Projections**
  - This is almost entirely due to the inclusion of **HB 951 for the electric sector** and **recent federal fuel economy and HFC policies**, none of which are included in the main NC GHG Inventory Projection



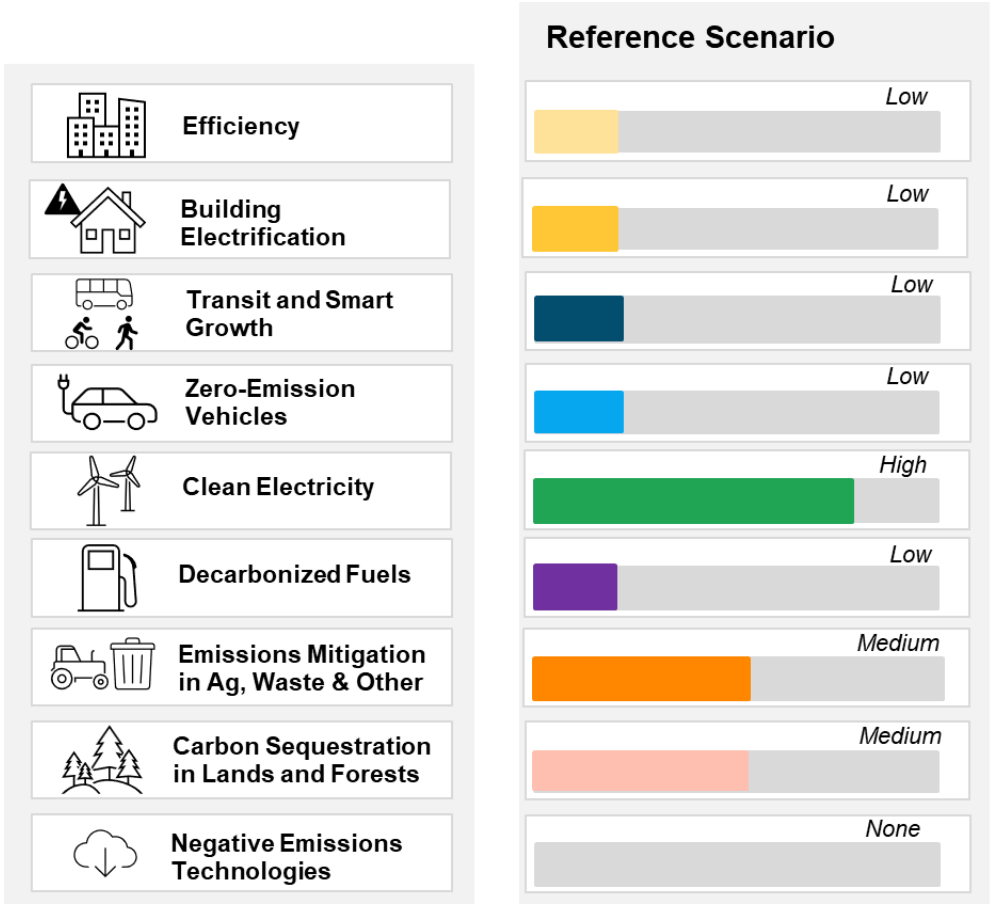
# Scenario Design

# Key Measures for Deep Decarbonization

| | |
|---|---|
|  **Efficiency** | **Efficiency** includes building codes, appliance standards, and customers choosing to replace older equipment with higher efficiency alternatives |
|  **Building Electrification** | **Building Electrification** includes switching from home appliances that use gas, oil or liquefied petroleum gas (LPG) to those using electricity, such as electric heat pump space heaters, heat pump water heaters, induction stoves, etc. |
|  **Transit and Smart Growth** | **Transit and Smart Growth** includes increased access to and use of public transit, urban planning to encourage growth in compact walkable and bike-able urban centers, etc. |
|  **Zero-Emission Vehicles** | **Zero-Emission Vehicles** include replacing gasoline- and diesel-powered vehicles with electric vehicles |
|  **Clean Electricity** | **Clean Electricity** includes increased electricity generation from renewables and zero-carbon sources to replace fossil-based sources |
|  **Decarbonized Fuels** | **Decarbonized Fuels** include commercialization and increased availability of biofuels, hydrogen and synthetic fuels produced from zero-carbon sources |
|  **Emissions Mitigation in Ag, Waste & Other** | **Emissions Mitigation in Agriculture, Waste & Other** includes improved management of landfills, agricultural land and manure to reduce methane emissions, reduced use of highly-potent greenhouse gas such as hydrofluorocarbon (HFC) in refrigerants |
|  **Carbon Sequestration in Lands and Forests** | **Carbon Sequestration in Lands and Forests** includes efforts to protect and restore forests and wetlands to increase carbon sequestration in natural and working lands |
|  **Negative Emissions Technologies** | **Negative Emissions Technologies** includes deploying technologies, such as direct air capture, which remove remaining hard-to-mitigation emissions to achieve net zero emissions by 2050 if needed |

# Reference Scenario for North Carolina

## *Level of Transformation by Measure*




Total numbers of households grow over time in pace with population growth and are built to current building codes and appliance standards. Customers replace any broken appliances with a similar model, i.e. like-for-like replacement

Total number of vehicles increase with population and existing driving patterns continue.
Moderate increases in electric vehicles, but no new policies or incentives

New renewables and storage are built to meet new electric sector goals (HB 951)

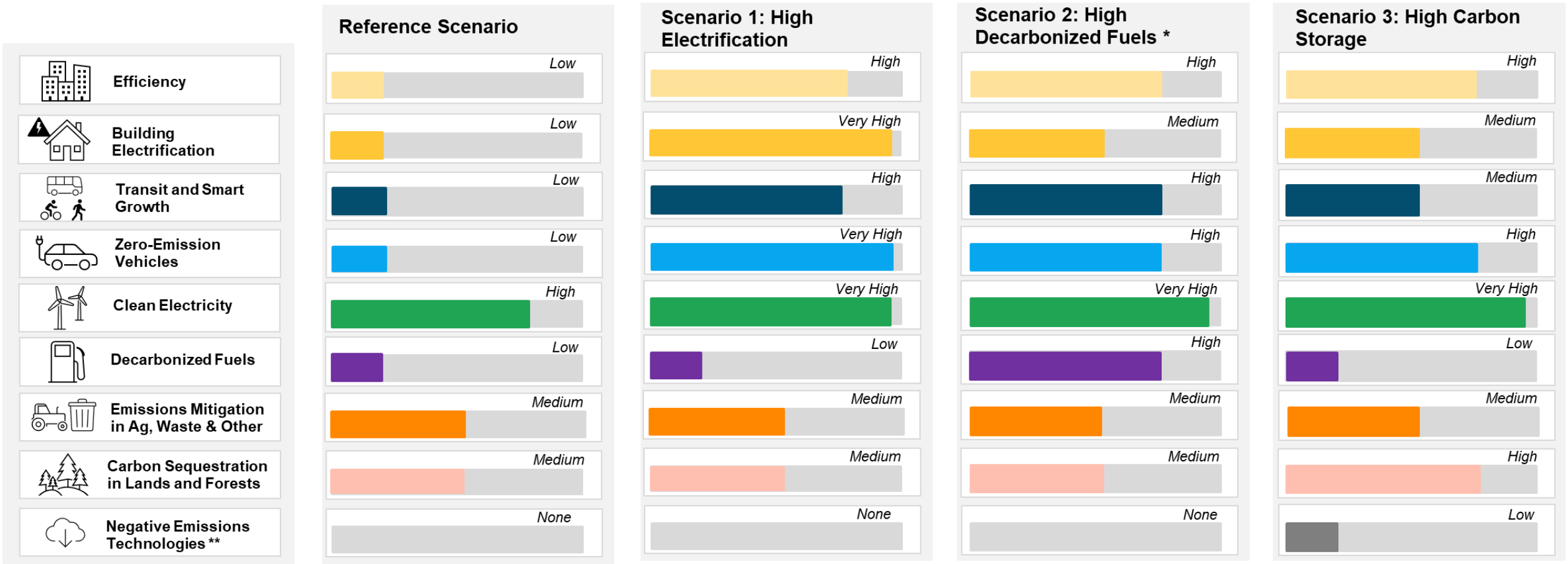
Existing biofuel blends continue (e.g. ethanol blended into motor gasoline)

Decreasing use of HFCs for refrigerants based on recent EPA rules

Medium-level of carbon sequestration through natural and working lands with no significant change from today's levels

# Scenario Design for North Carolina

## *Level of Transformation by Measure*




* E3 is planning on conducting a lower-efficiency sensitivity on the High Decarbonized Fuels scenario to evaluate the impact of high levels of energy efficiency measures modeled in the core scenario

** Negative Emissions Technologies will only be used to achieve net zero by 2050 if needed in the High Carbon Storage scenario

# How can you stay engaged?

## + Feedback is welcome:

- What measures, actions, or policies are you excited to see in a decarbonization scenario?
- What concerns do you have and what challenges do you expect in North Carolina reaching the climate goals?
- What additional considerations would you recommend for the NC Pathways Analysis?
- *Feedback can be submitted by August 19th* to contactgov@nc.gov
- *Website to stay up to speed on the Pathways and learn more: https://governor.nc.gov/issues/environment*

## + Next Steps:

- E3 will finalize the Reference scenario and start modeling mitigation scenarios
- E3 will present draft mitigation scenario results at the next public meeting (TBD in October)

# Appendix

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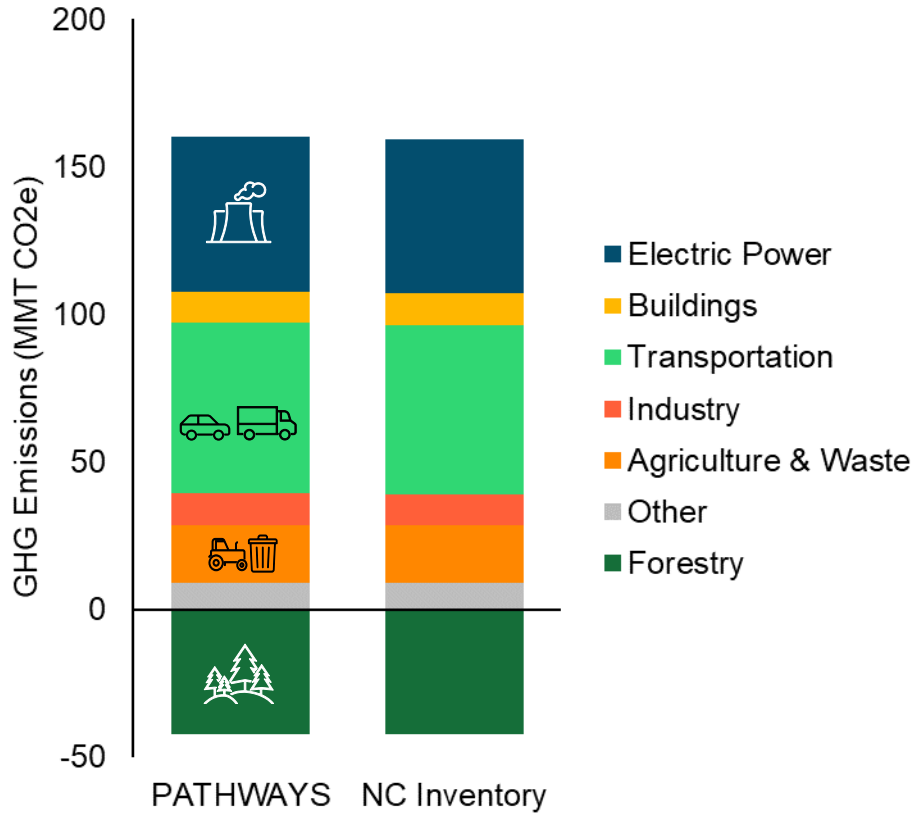
# Members of the Technical Advisory Group

+ **Academic Research**
  - Brian Murray- Interim Director, Nicholas Institute and Duke University Energy Initiative
  - Jeremiah Johnson- Associate Professor, NC State University
  - Robert Cox- Associate Director, UNC Charlotte Energy Production and Infrastructure Center
+ **Power Sector**
  - Mark McIntire- Director of Government Affairs, Energy and the Environment and Stakeholder Engagement, Duke Energy
  - Michael Youth- Government and Regulatory Affairs Counsel, North Carolina's Electric Cooperatives
  - Ward Lenz- Executive Director, NC Sustainable Energy Association
+ **Transportation Sector**
  - Catherine Kummer- Sustainability, Resiliency and Governmental Affairs Officer, Charlotte Area Transit System
  - Heather Brutz- Transportation Finance and Operations Manager, NC Clean Energy Technology Center
+ **Residential, Commercial, and Industrial**
  - Kevin Martin- Executive Director, Carolina Utility Customers Association
  - Ross Smith- President, NC Manufacturers Alliance
  - Thomas Pheonix- Principal, CPL Architects and Engineers
+ **Land Use, Land-Use Change and Forestry**
  - Justin Baker- Associate Professor, NC State University
  - Lydia Olander- Director of the Ecosystem Services Program, Duke University
+ **Public Interest**
  - Al Ripley- Director, Consumer, Housing & Energy Project, NC Justice Center
  - Amanda Levin- Interim Director of Policy Analysis, Natural Resources Defense Council
  - Sherri White-Williamson- Environmental Justice Policy Director, NC Conservation Network

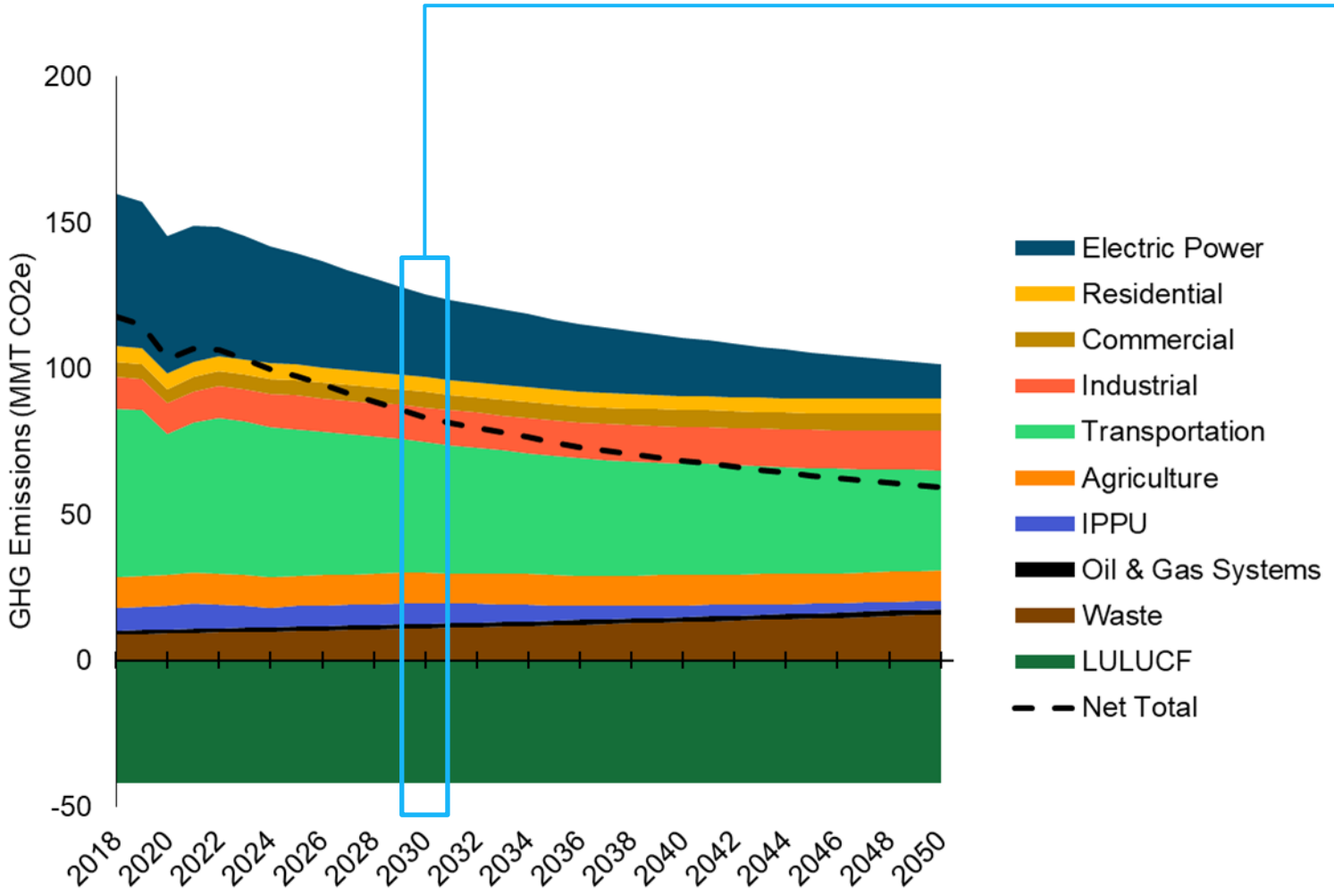
# Benchmarking with NC Greenhouse Gas (GHG) Inventory

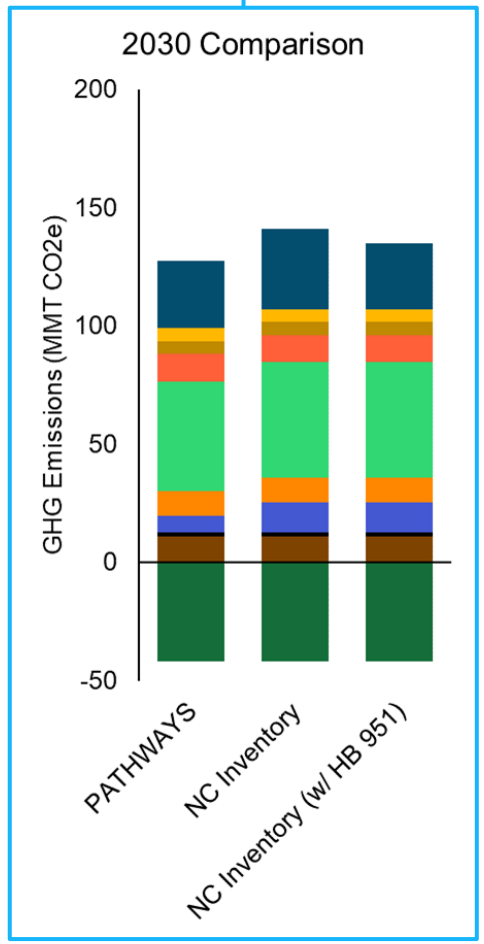
## Base Year 2018 GHG Emissions Comparison




- **The NC PATHWAYS model is fully benchmarked to the latest NC State GHG Inventory (*released January 2022 by the NC Department of Environmental Quality*)**
  - Both *GHG emissions* and *final energy demand* are consistent with the analysis supporting the NC GHG Inventory
- **Total emissions in PATHWAYS are within <1% of NC Inventory**

# Reference Scenario Draft Results: GHG Emissions by Sector




## 2030 Emissions Deltas

(PATHWAYS minus NC Inventory with HB 951)

| Sector | MMT $CO_2e$* |
|---|---|
| Electric Power | 0 |
| Residential | 0 |
| Commercial | 0 |
| Industrial | 1 |
| Transportation | -4 |
| Agriculture | 0 |
| IPPU | -5 |
| Oil & Gas | 0 |
| Waste | 0 |
| LULUCF | 0 |
| Net Total | -8 |

**Rounded to nearest 1 MMT $CO_2e$, totals may not sum to Net Total due to rounding*

# NC PATHWAYS Key Drivers

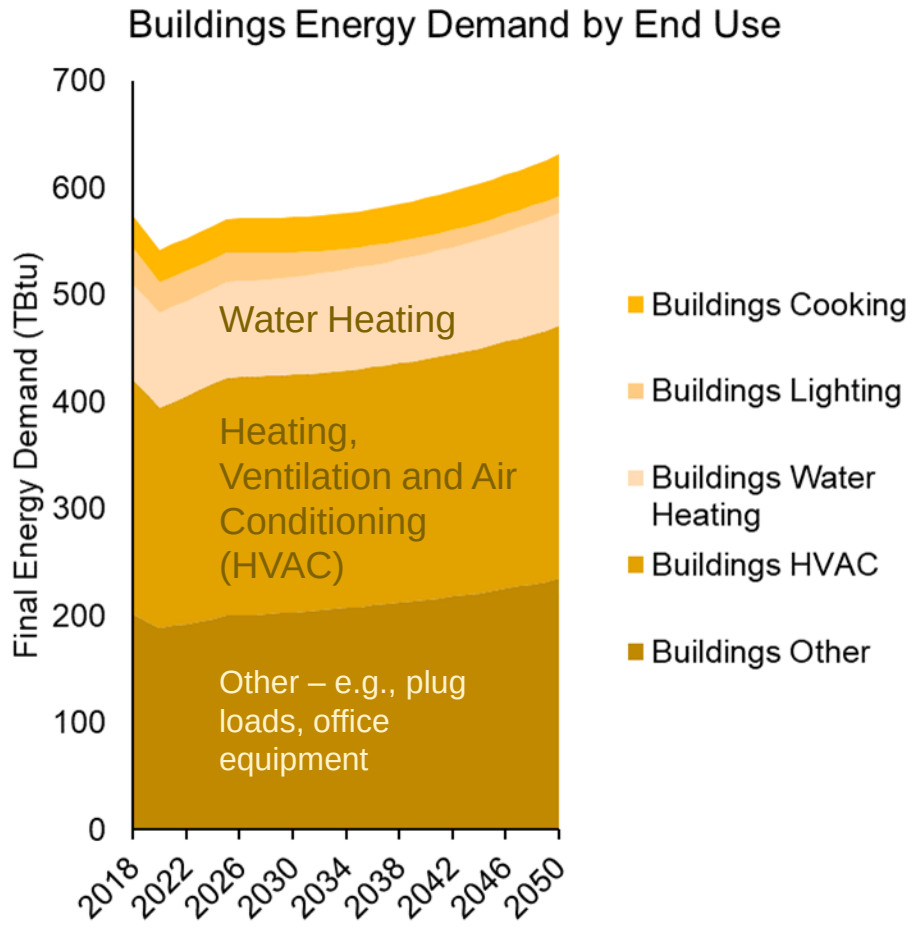
| Sector | Key Driver for Underlying Growth | Key Driver Annual Growth Rate | Key Driver Source |
|---|---|---|---|
| Residential | Households | 1.6% | NC Office of State Budget and Management & U.S. Energy Information Administration (EIA) Annual Energy Outlook 2022 |
| Commercial | Commercial Sq. Footage | 1.0% | EIA Annual Energy Outlook 2022 |
| Transportation | VMT* | 0.8% *(avg across vehicle classes)* | NC Department of Environmental Quality Motor Vehicle Emission Simulator 3 (MOVES3) modeling used for NC Greenhouse gas (GHG) Inventory |
| Industrial | Industrial Fuel Use | Varies by Fuel | EIA Annual Energy Outlook 2022 |
| Non-Energy, Non-Combustion (incl. Agriculture, Waste, Industrial Processes & Product Uses) | Direct GHG Emissions | Varies by Gas/Source | NC GHG Inventory Projection |
| Land-Use, Land-Use Change, and Forestry (LULUCF) | Annual $CO_2$ flux | TBD | Currently held constant at 2018 levels per NC GHG Inventory Projection |
| Electricity Generation** | Annual load growth | TBD | Bottom-up estimates from assumptions in buildings, transportation, and industry |

**VMT reported here as average, but individual growth rates are used for each vehicle type in PATHWAYS (e.g., Light Duty Cars, Medium and Heavy Duty Trucks, Buses)*

***Detailed electricity generation modeling not included in this analysis*

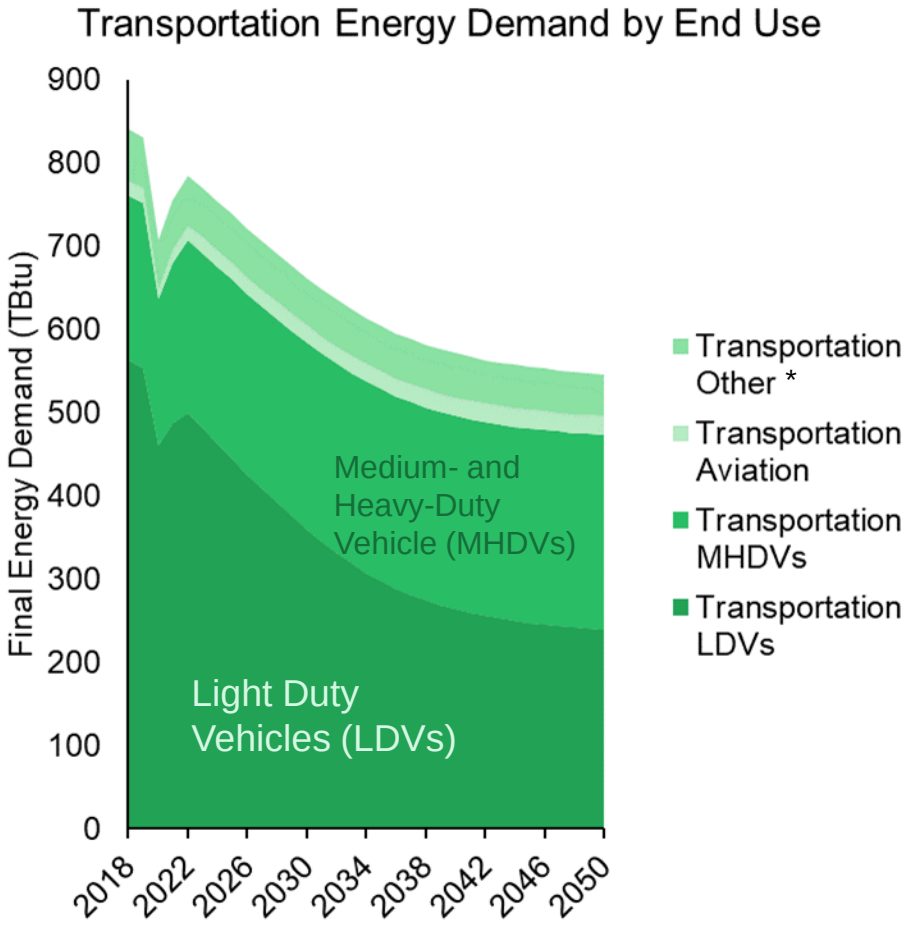
# Reference Scenario Key Assumptions – Buildings

| Category | Reference Scenario Assumptions |
|---|---|
| Households Growth | 1.6% annual growth rate based on NC Office of State Budget and Management population projections & U.S. Energy Information Administration (EIA) Annual Energy Outlook 2022 ratio of households to population growth |
| Commercial Square Footage Growth | 1.0% annual growth rate based on EIA Annual Energy Outlook 2022 |
| Appliance Efficiency | Improvements to appliance efficiency based on EIA Annual Energy Outlook 2022 (includes federal minimum efficiency requirements) |
| Building Shell Efficiency | All new construction meets existing North Carolina statewide building code |
| Electrification | No incremental electrification of fossil fuel use in buildings |



# Reference Scenario Key Assumptions – Transportation

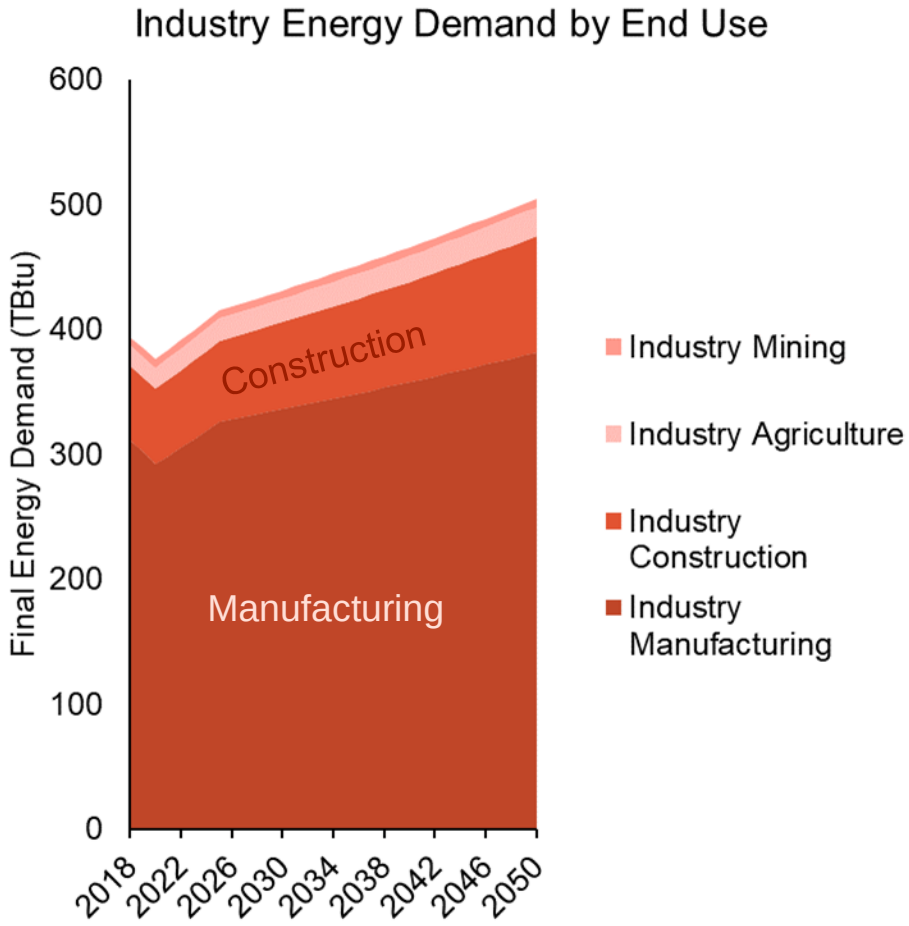
| Category | Reference Scenario Assumptions |
|---|---|
| Vehicle Miles Traveled (VMT) Growth | 0.8% annual growth rate for total statewide VMT consistent with modeling performed for NC GHG Inventory (*working with NC Department of Transportation to align with the VMT Reduction Study*) |
| Light Duty Vehicle Fuel Economy | Fuel economy improvements reflect updated National Highway Traffic Safety Administration's (NHTSA's) Corporate Average Fuel Economy (CAFE) standards for model years 2024-2026 |
| Light Duty Vehicle Zero Emission Vehicles (ZEVs) | Battery Electric Vehicle sales share reaches 8% in 2030 and 35% in 2050, consistent with sales forecast from NHTSA's CAFE analysis |
| Medium- and Heavy-Duty Vehicle Fuel Economy | Fuel economy improvements from U.S. Energy Information Administration (EIA) Annual Energy Outlook 2022 used for MHDVs |
| Medium- and Heavy-Duty Vehicle ZEVs | ZEV sales less than 1% sales share through 2050, consistent with projections from EIA Annual Energy Outlook 2022 |




**Transportation Other includes boats, locomotives, and other non-highway petroleum consumption in equipment*

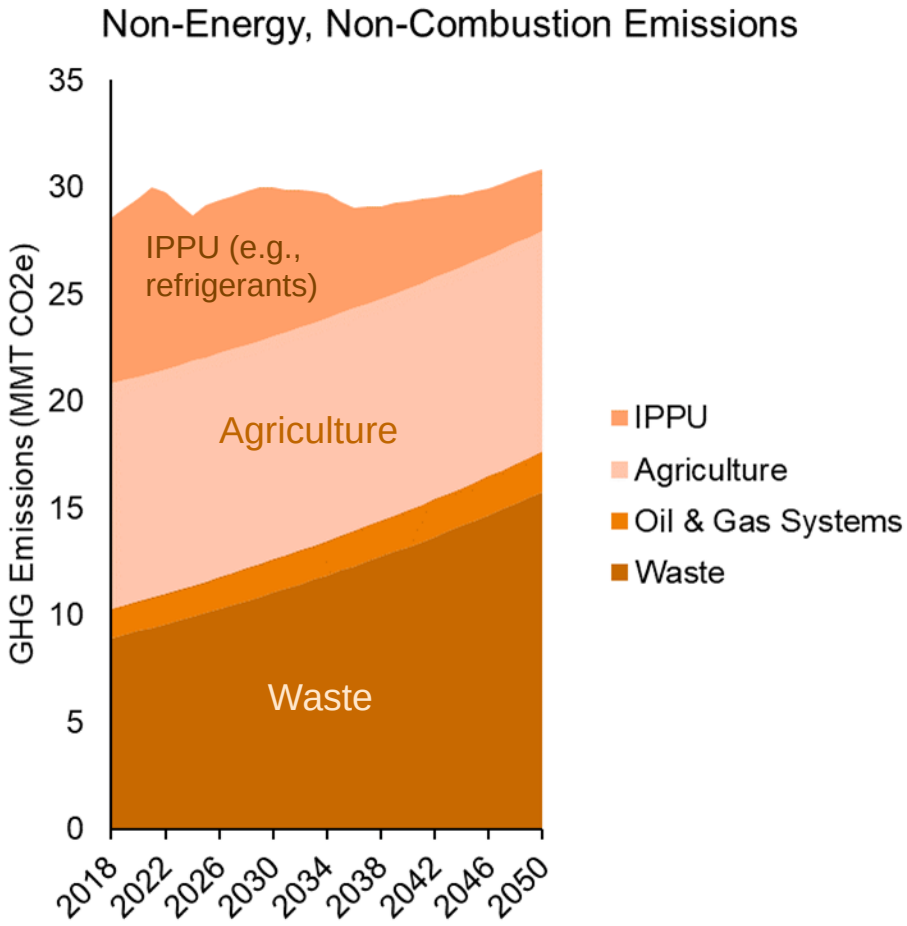
# Reference Scenario Key Assumptions – Industry

| Category | Reference Scenario Assumptions |
|---|---|
| Industrial Energy Demand | Industrial subsector and fuel-specific growth rates from the U.S. Energy Information Administration (EIA) Annual Energy Outlook 2022 Reference case |



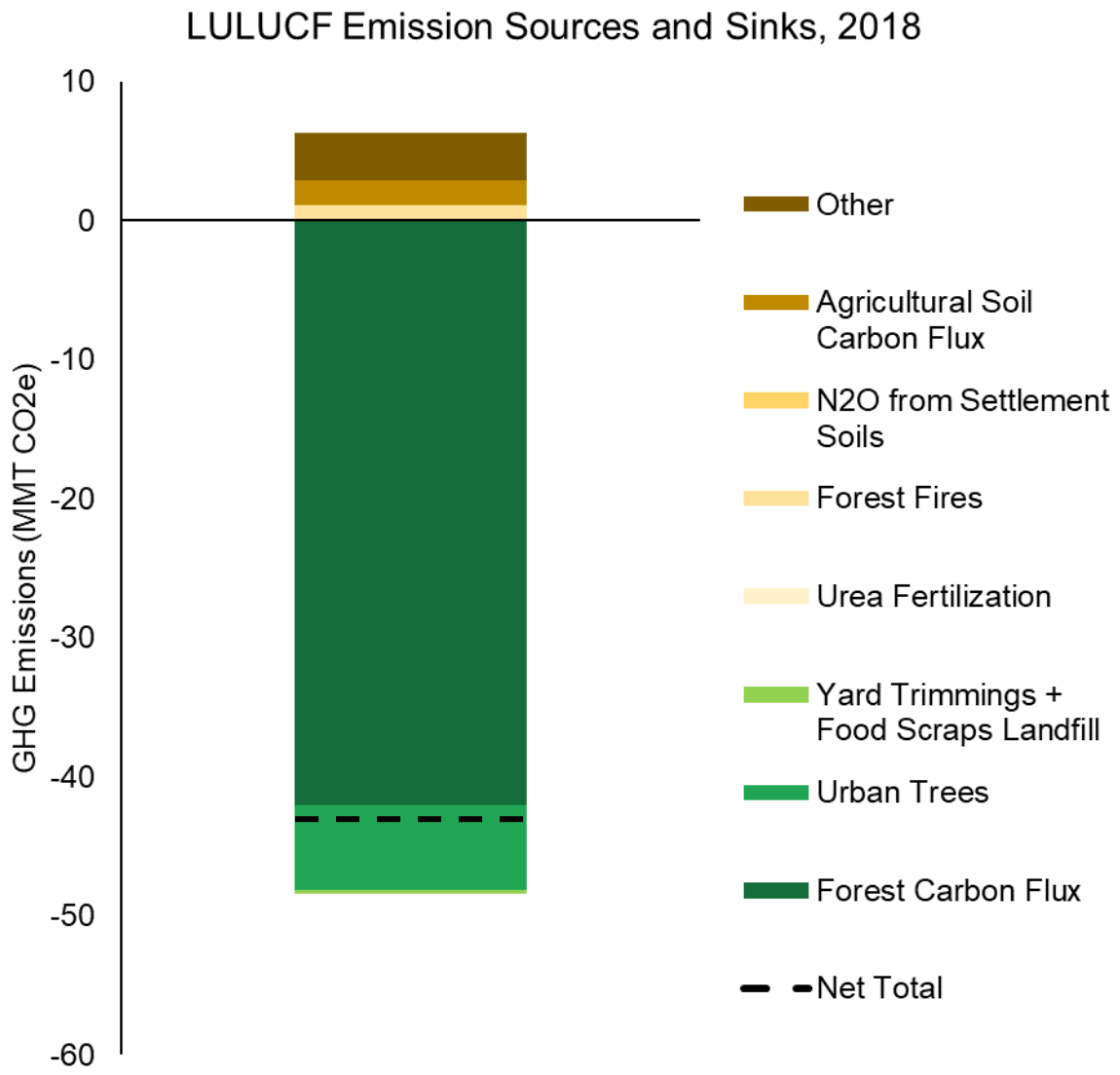
# Reference Scenario Key Assumptions – Non-combustion

| Category | Reference Scenario Assumptions |
|---|---|
| Industrial Process and Product Use (IPPU) | Reduction in Hydrofluorocarbon (HFC) emissions based on national reductions forecasted by EPA in final rulemaking for HFC phasedown program |
| Agriculture | -0.1% annual growth rate based on NC GHG Inventory Projection |
| Oil & Gas Systems | 1.0% annual growth rate based on NC GHG Inventory Projection |
| Waste | 1.8% annual growth rate based on NC GHG Inventory Projection |



# Reference Scenario Key Assumptions – LULUCF

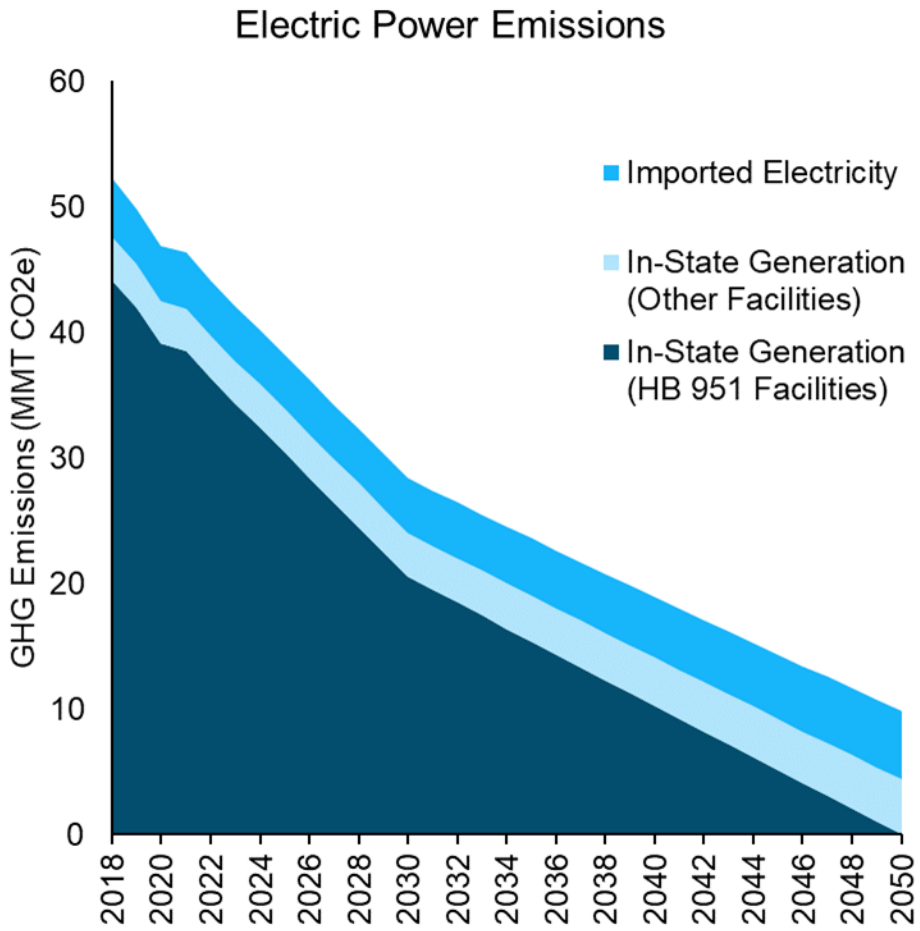
| Category | Reference Scenario Assumptions |
|---|---|
| Land Use and Land Use Changes and Forestry (LULUCF) | 2018 magnitude of LULUCF net carbon sink is held constant over modeling horizon in keeping with NC GHG inventory projection **(42 MMT CO2e)** |



# Reference Scenario Key Assumptions – Electricity Generation

| Category | Reference Scenario Assumptions |
|---|---|
| Electric Power | Impacts of House Bill 951 / Session Law 2021-165 are included in electric sector emissions trajectory, leading to a 65% reduction from 2005 total electric sector emission levels in 2030 and an 85% reduction in 2050 |

+ **Remaining emissions in 2050 are from imports and small electric utilities**
  - HB 951 emission reduction targets apply only to in-state generation and electric utilities serving >150,000 customers
  - Emissions from non-HB 951 in-state facilities and imported electricity are calculated using same emissions intensities as NC GHG Inventory but scaled to PATHWAYS load outputs after 2022



# Proposed Measures by Scenario

## *Buildings and Transportation*

| Sector | Measure | High Electrification | High Decarbonized Fuels | High Carbon Storage |
|---|---|---|---|---|
| **Buildings** | **Energy Efficiency** | • All newly sold appliances are high efficiency models by 2030<br>• Adoption of the latest 2021 International Energy Conservation Code (IECC) building code for new construction<br>• Building shell retrofits | | |
| | **Electrification** | • All-electric new construction standard by **2030**<br>• 100% sales of electrified devices for all end uses (space and water heating, drying, cooking) by **2035** | • All-electric new construction standard by **2040**<br>• 100% sales of electrified devices for all end uses (space and water heating, drying, cooking) by **2050** | |
| **Transportation** | **Vehicle Miles Traveled (VMT) Reductions** | **High levels** of VMT reduction from transit and smart growth based on the VMT Reduction Study, upon further discussion with NC Department of Transportation (DOT) and the Clean Transportation Plan (CTP) team | | **Moderate levels** of VMT reduction from transit and smart growth, upon further discussion with NCDOT and the CTP team |
| | **Light-duty Zero Emission Vehicles (ZEVs)** | 100% ZEV sales by **2035** | 100% ZEV sales by **2045** | |
| | **Medium- and Heavy-duty ZEVs** | 100% ZEV sales by **2045** | 100% ZEV sales by **2050** | |
| | **Off-road Gasoline and Diesel Electrification** | Electrify gasoline and diesel at same rate as MHDV | Electrify gasoline and diesel at same rate as MHDV | |

# Proposed Measures by Scenario

## *Industry, Electricity Generation and Biofuels*

| Sector | Measure | High Electrification | High Decarbonized Fuels | High Carbon Storage |
|---|---|---|---|---|
| Industry | **Manufacturing Energy Efficiency** | 16% reduction in manufacturing energy demand through efficiency by 2050 based on the American Council for an Energy-Efficient Economy (ACEEE) Halfway There report | | |
| | **Natural Gas Electrification** | Electrify natural gas use based on NREL Electrification Futures Study **High Electrification scenario** | Electrify natural gas use based on NREL Electrification Futures Study **Medium Electrification scenario** | |
| | **Liquid Fuels Electrification** | Electrify gasoline and diesel at same rate as MHDV | Electrify gasoline and diesel at same rate as MHDV | |
| | **Hydrogen Fuel-switching** | Convert remaining natural gas use to hydrogen combustion (total will vary by scenario), convert all coal combustion to hydrogen | | |
| **Electricity Generation** | **Emission Reductions** | 70% reduction in emissions by 2030, 100% by 2050 (House Bill 951 reduction levels but for all sources, not just in-state sources subject to HB 951 requirements) | | |
| Biofuels | **Sustainability Screening** | Focus on advanced biofuels produced from wastes/residue feedstocks rather than energy crops | | |
| | **Available Supply** | Existing blends of ethanol and biodiesel held constant | Additional advanced biofuels using in-state wastes and residue feedstocks | Existing blends of ethanol and biodiesel held constant |

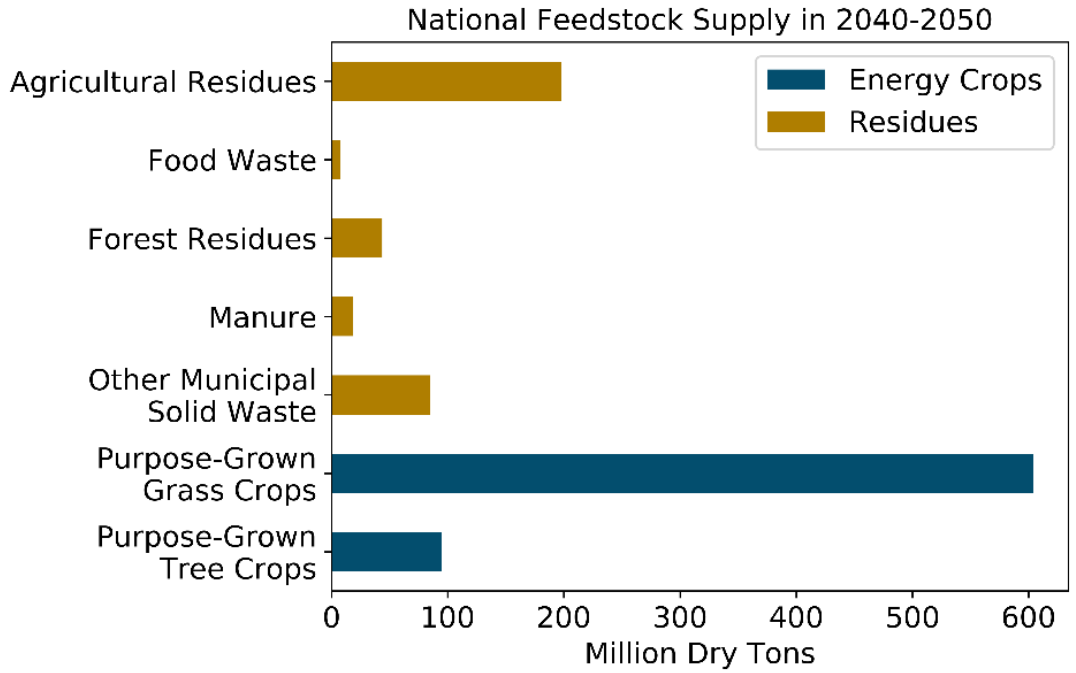
# Proposed Measures by Scenario

## *Non-Combustion Emissions and Carbon Sequestration*

| Sector | Measure | High Electrification | High Decarbonized Fuels | High Carbon Storage |
|---|---|---|---|---|
| Non-Combustion | **Waste Management Methane Reductions** | Reductions available below $100/tCO2e from 2019 EPA Non-CO2 Report | | |
| | **Agriculture Methane and N2O Reductions** | Reductions available below $100/tCO2e from 2019 EPA Non-CO2 Report | | |
| | **Hydrofluorocarbon (HFC) Phaseout** | HFC phaseout in line with new proposed EPA program | | |
| Carbon Sequestration | **Land Use and Land Use Change and Forestry (LULUCF)** | LULUCF sink held constant at 2018 levels | | Achievement of reforestation potential identified in NC Natural and Working Lands Action Plan |
| | **Negative-Emissions Technologies (NETs)** | None | | NETs, such as direct air capture, to offset any remaining emissions will only be used if need to achieve net zero in 2050 |

# Screening of Feedstock Potential

- **E3 relies mostly on the DOE Billion Ton Report and NREL Biogas Potential in the United States Study to estimate the quantity and location of eligible biofuel feedstocks, including two major categories of feedstock:**
  - **"Residues"** include feedstocks such as agricultural residues, forest thinnings, and food waste
  - **"Energy Crops"** include dedicated land to grow high-energy crops or new forests for conversion to biofuels
- ***For this analysis*, E3 plans to screen the availability of feedstock for biofuel production based on two main criteria:**
  - **Geographic locations,** e.g. assuming access to only in-state biomass feedstock, or NC's population-weighted share of national feedstock
  - **Land use and sustainability concerns,** e.g. excluding dedicated energy crops from the feedstock supply curve. Only feedstocks from wastes and residues will be considered




*Source: DOE, 2016. Billion Ton Update*