North Carolina Deep Decarbonization Pathways Analysis

Public Engagement Session #3

January 18th, 2023

Office of Governor Roy Cooper

Energy+Environmental Economics

Agenda

- **Welcome – Office of Governor Roy Cooper (5 min)**
- **Project Background and Recap of Previous Sessions (15 min)**
- **Final Scenario Results (40 min)**
  - Final Modeling Updates Following E.O. 271
  - Recap of Key Findings
  - Roadmap to Net Zero
- **Public Input and Next Steps – E3 and Governor's Office (30 min)**
  - Feedback + Q&A
  - Next Steps

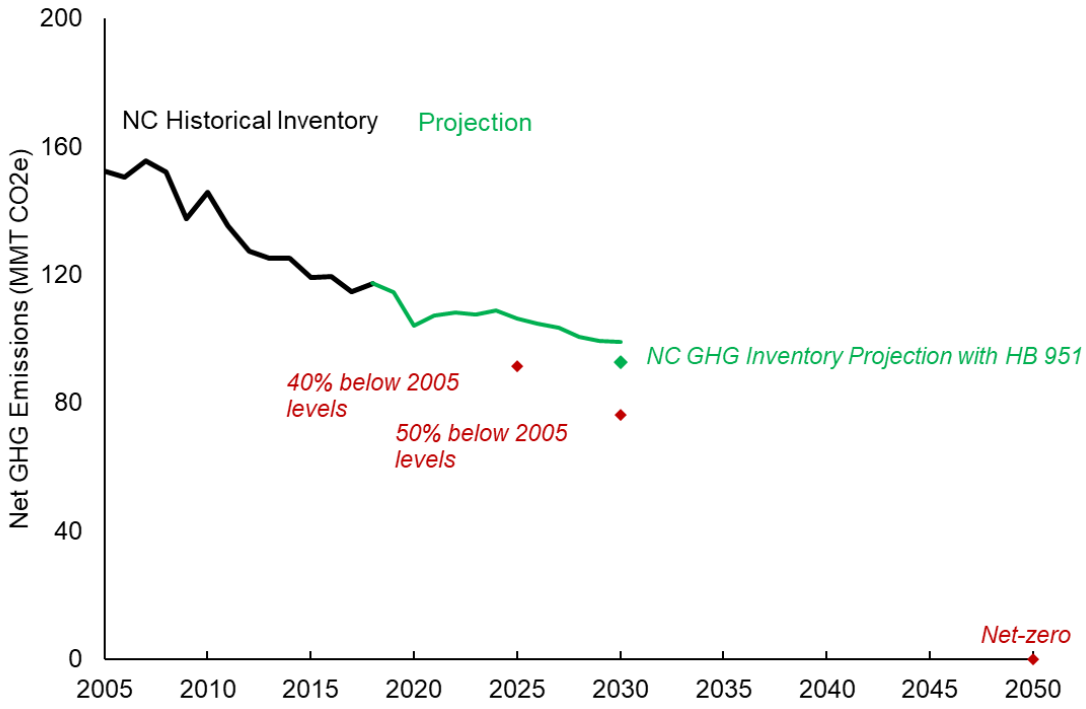
Climate Action in North Carolina

- **Executive Order No. 80,** issued in 2018, established a goal for North Carolina to:
  - Reduce GHGs at least 40% below 2005 levels by 2025.
- **Executive Order No. 246** established 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
- EO 246 also directed 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. MOVES for transportation, Duke forecasts) and incorporate the impact of HB 951

Background on Project

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Project Scope

+ Goals

- Analyze various technologically feasible GHG emissions reduction pathways to achieve NC's economy-wide GHG targets (40 by 2025; 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		Oct 18			Jan 18

Public Engagement Sessions

	Aug	Sep	Oct	Nov	Dec	Jan
Public Engagement Sessions						

- **Public Engagement Session #1 (August 11):** Introducing the pathways analysis scope, process and scenario design and soliciting public feedback
- **Public Engagement Session #2 (October 18):** Presenting draft scenario results and soliciting public feedback
- **Public Engagement Session #3 (Today):** Presenting updated final scenario results and soliciting public feedback

Recap of Modeling Approach

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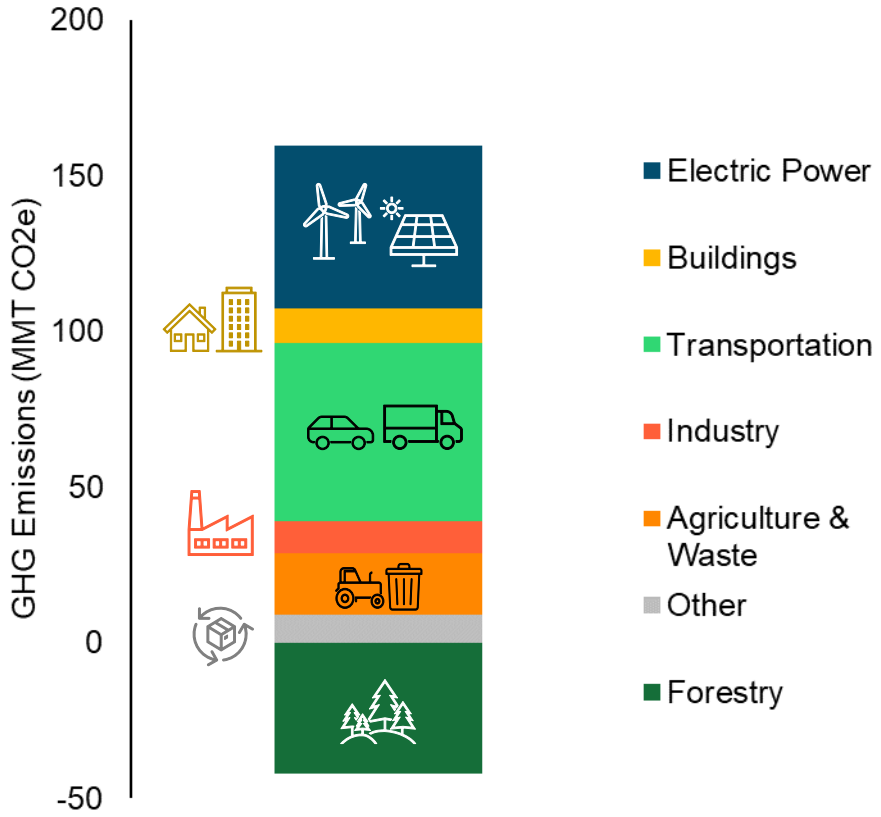
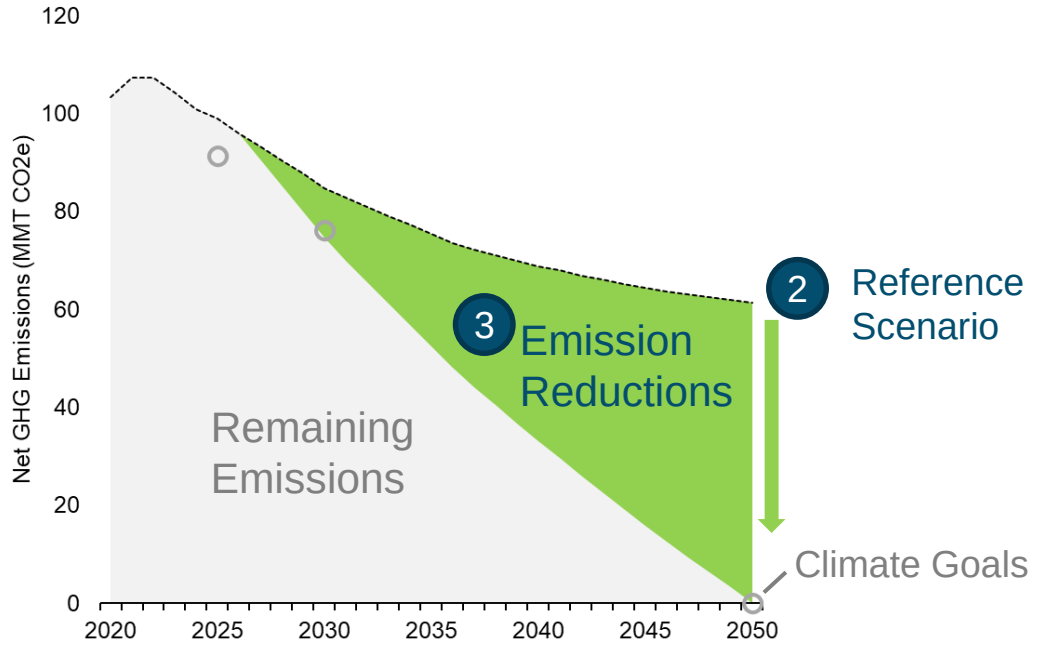
Steps of a PATHWAYS study

1 Measure current greenhouse gas emissions in North Carolina



2 Estimate future emissions based on current trends and existing policies



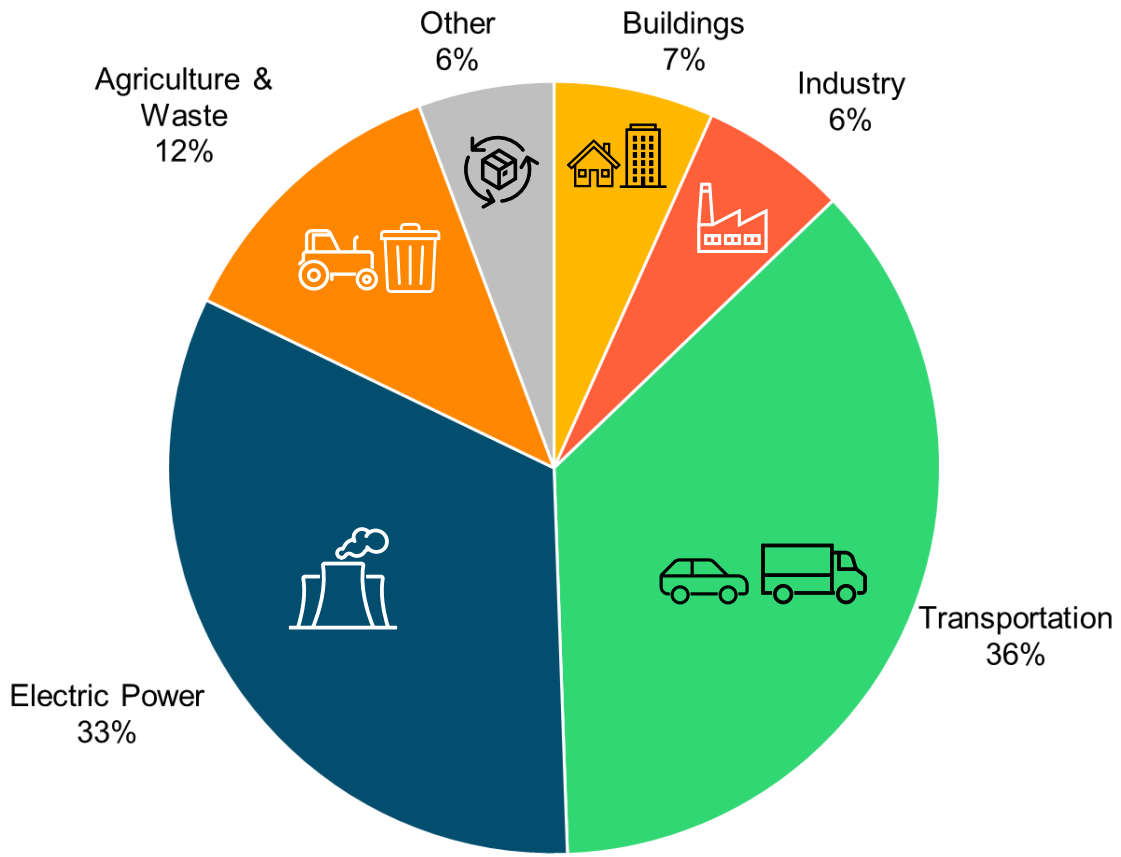
3 Evaluate impact of new potential measures and actions that would help the state meet climate goals

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

Current Emissions and Initiatives by Sector

1

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**

Priority actions that impact emissions

Buildings

- Increased sales of high efficiency appliances
- Adoption of improved building shells in both new and retrofit buildings
- All-electric new construction standards
- Increased sales of electrified devices for all end uses (space and water heating, drying, cooking)

Transportation

- Improved fuel economy for new vehicles sold
- Reductions in vehicle-miles traveled through transit and smart growth
- Increased sales of zero-emission vehicles (ZEVs), including, battery-electric and hydrogen fuel cell vehicles

Clean Electricity

- Scale up of renewable electricity sources (wind and solar), and battery storage
- Targeted role for zero-carbon firm generation

Decarbonized Fuels

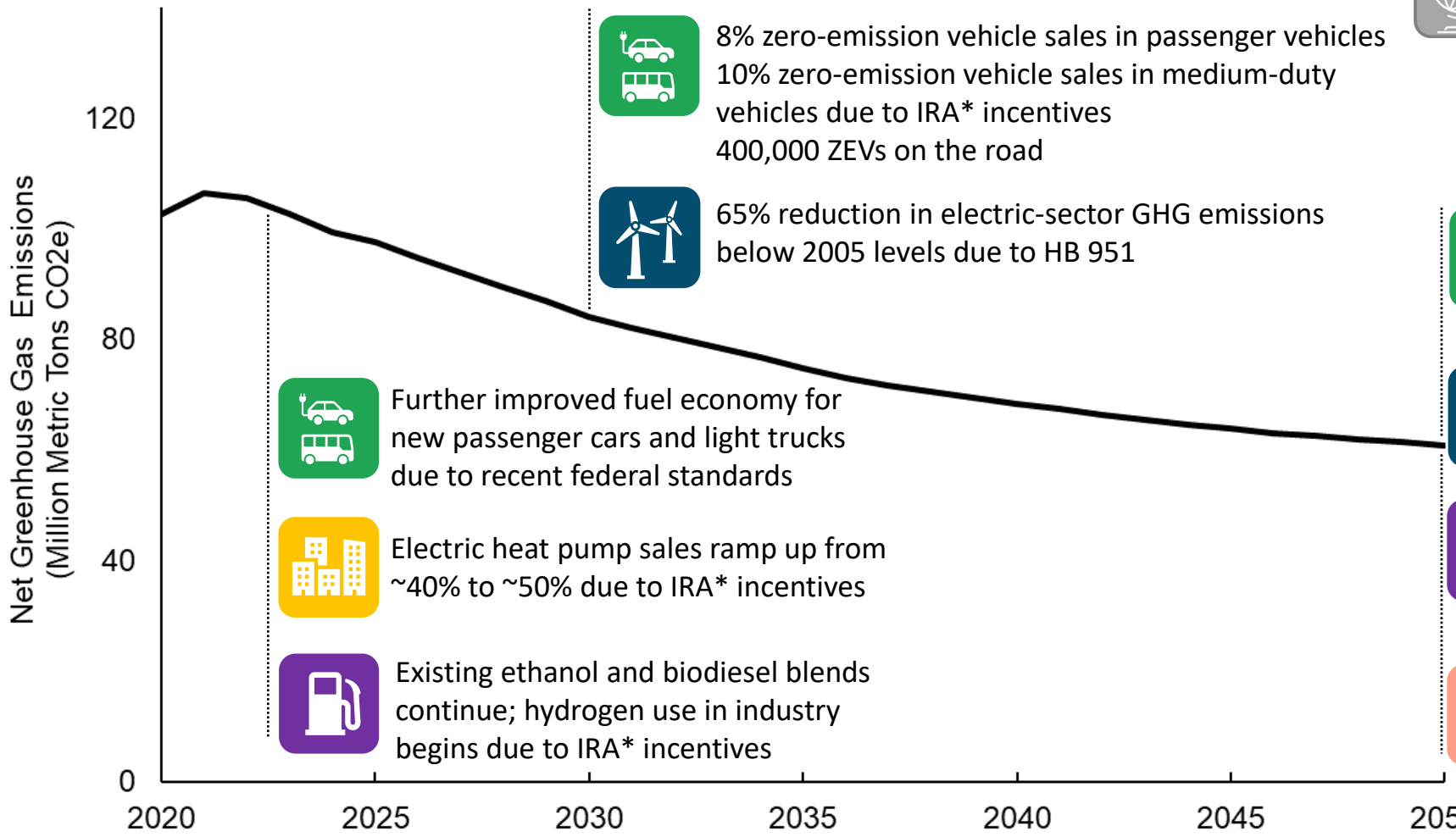
- Production of advanced biofuels with sustainable biomass feedstocks
- Production of green hydrogen through electrolysis using renewable electricity

Carbon Sequestration

- Reforestation and restoration to enhance carbon sinks from natural and working lands
- Deployment of negative emissions technologies such as direct air capture of CO2 (DAC)

Final Scenario Results

North Carolina Greenhouse Gas Emissions Reduction Measures Reference Scenario



8% zero-emission vehicle sales in passenger vehicles
10% zero-emission vehicle sales in medium-duty vehicles due to IRA* incentives
400,000 ZEVs on the road

65% reduction in electric-sector GHG emissions below 2005 levels due to HB 951

Further improved fuel economy for new passenger cars and light trucks due to recent federal standards

Electric heat pump sales ramp up from ~40% to ~50% due to IRA* incentives

Existing ethanol and biodiesel blends continue; hydrogen use in industry begins due to IRA* incentives

Population and total vehicle miles travelled (VMT) continue to grow at 0.94%/year, while households and commercial square footage are projected to grow at 1.6%/year and 1%/year respectively.

35% zero-emission vehicle sales in passenger vehicles, 2 million zero-emission passenger vehicles on the road

85% reduction in electric-sector GHG emissions below 2005 levels due to HB 951

13 TBtu of hydrogen use in industry replacing natural gas due to continued trend post IRA* incentives

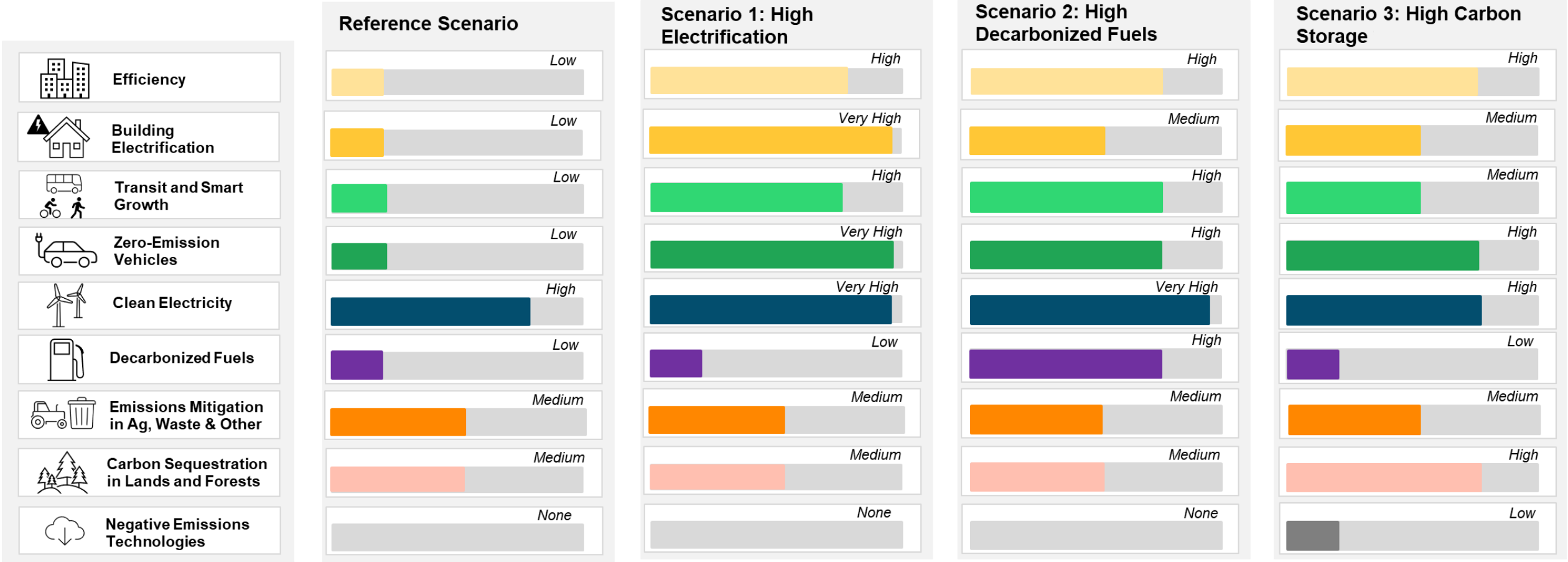
Existing carbon sequestration through natural and working land declines slightly over time due to projected loss of forests and sea level rise impacts

*Inflation Reduction Act of 2022

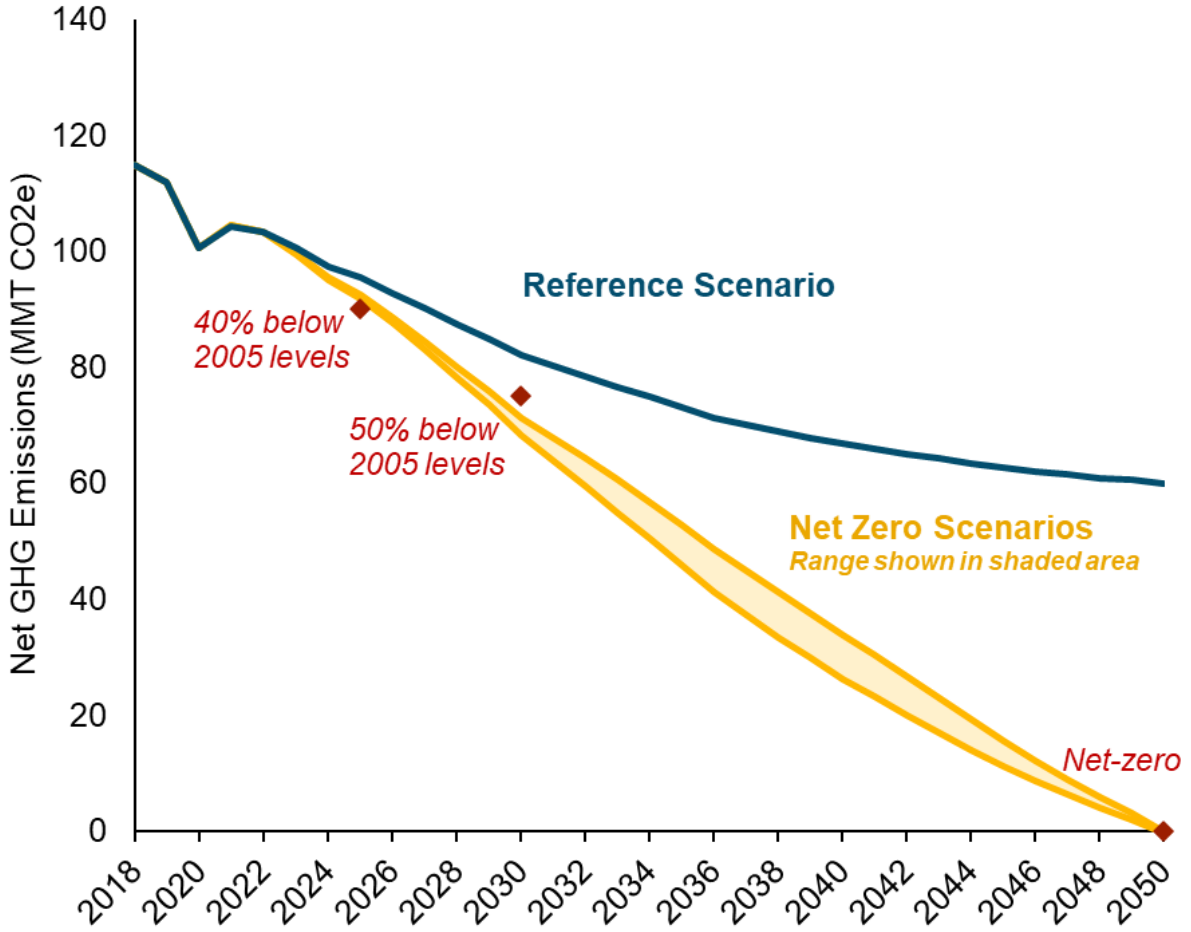
Note: Impacts of the Inflation Reduction Act are uncertain, current assumptions in appendix

Net Zero Scenario Design

Level of Transformation by Measure



Net GHG Emissions by Scenario

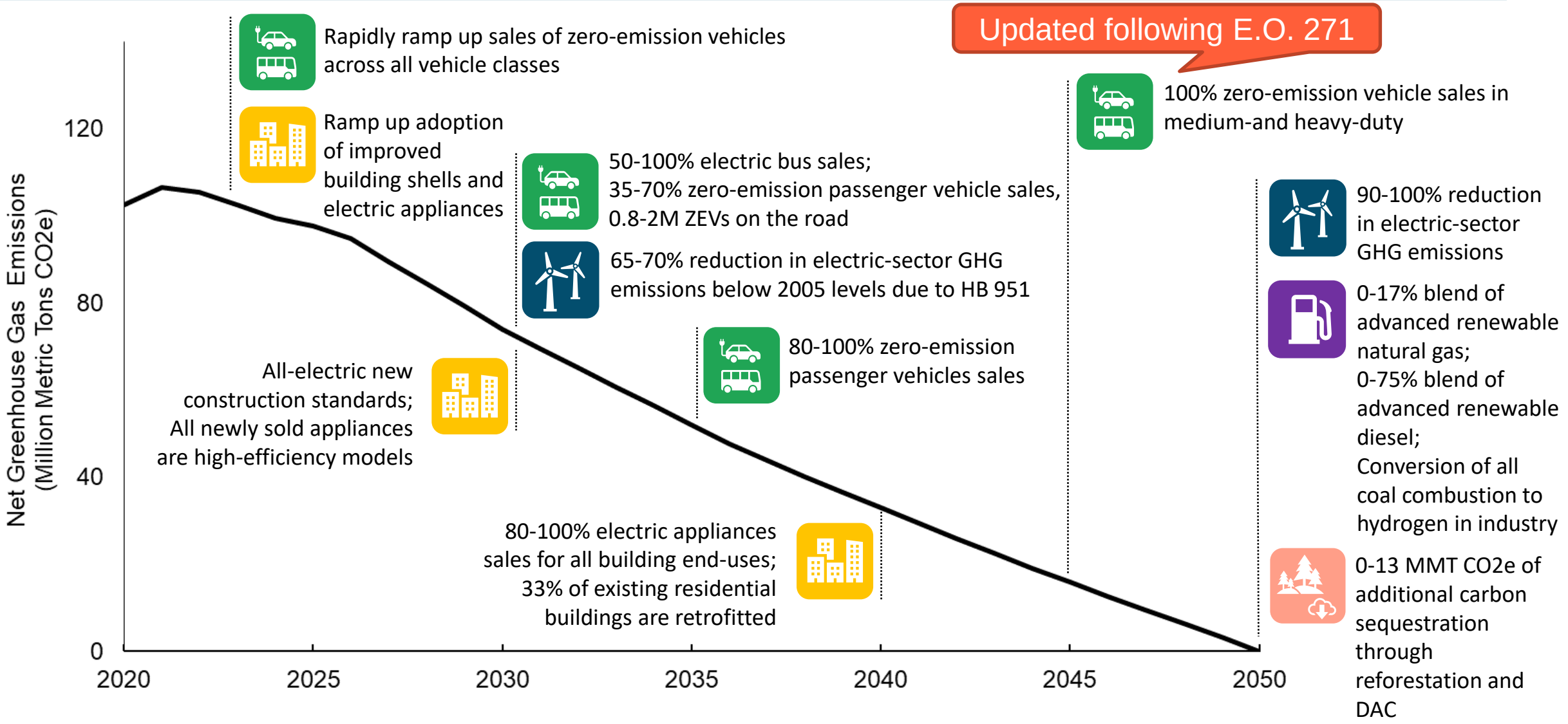


+ **All three net zero scenarios have a similar trajectory for net GHG emissions**
  - All net zero scenarios are within 1% of the 2025 GHG target and exceed the 2030 target
  - The exact trajectory will be highly dependent on the electricity sector, which will result from NCUC's decision-making on the Carbon Plan

+ **Many of the key differences between the net zero scenarios (e.g., electrification vs. decarbonized fuels vs. carbon storage) have a similar impact on the total net emissions shown here, but have different implications for the nature and timing of the energy system transition in North Carolina**

Draft and Preliminary

North Carolina Greenhouse Gas Emissions Reduction Measures Net Zero Scenario Ranges



Final Modeling Updates

+ Following Executive Order 271, E3 updated medium- and heavy-duty Zero-Emission Vehicles (ZEVs) sales to align with Advanced Clean Trucks

- Previously, the High Electrification scenario was the only one of the three net-zero scenarios where medium- and heavy-duty ZEV sales aligned with the Advanced Clean Trucks rule
- Given the recent EO directing the state to develop an ACT program, we have updated the scenarios so that all three net-zero scenarios achieve ZEV sales aligned with such a program

+ E3 refined non-CO2 abatement potential based on state-specific data from EPA

- Previous estimates of non-CO2 abatement potential used in the net-zero scenarios were based on national estimates from EPA, but we updated these to align with state-specific data from EPA.
- This has the largest impact in the agriculture sector, where the net-zero scenarios now have an additional 2 MMT of abatement in 2050

Recap of Key Findings: There are multiple pathways to meeting NC's 2030 and 2050 climate targets.

+ The commonalities across all scenarios represent near-term opportunities for "no-regret" actions:

1. Accelerate a **transition to zero-emission vehicles and electric heat pumps** in buildings

2. Rapidly **decarbonize electricity generation** by scaling up renewable electricity sources and battery storage

3. Encourage **high levels of energy efficiency**, such as adoption of efficient appliances and vehicles, improvement of building shells and reduction in vehicle miles traveled

4. Support commercialization of **decarbonized fuels**, at a minimum to green hydrogen for industry and large trucks, and exploring pilots for advanced biofuels using sustainable biomass feedstocks

5. Reduce **non-energy GHG emissions** from industry, agriculture, waste, and oil and gas systems

6. Prioritize **sustainable management of natural and working lands** to enhance the critical role of carbon sequestration in helping achieve net zero emissions

7. Reduce **fuel combustion** while decarbonizing the economy to create co-benefits for air quality improvement

Roadmap to Net Zero

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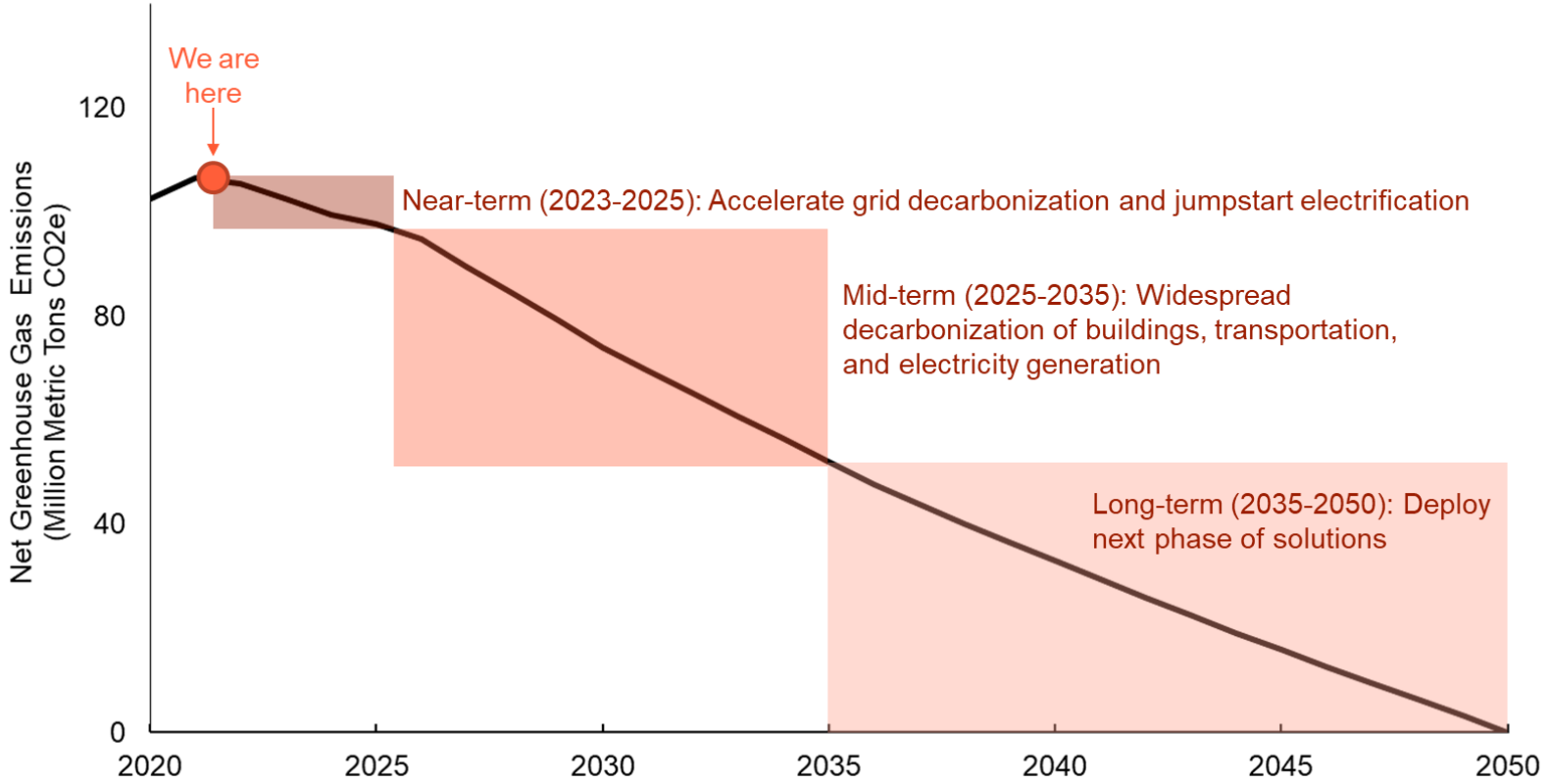
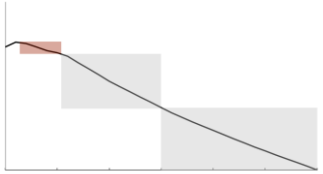
Roadmap to Net Zero

- NC Decarbonization Pathways analysis highlights the critical need to transform every sector of the economy on a path to net zero.
- The Roadmap to Net Zero outlines more targeted recommendations and identifies timely opportunities to reduce GHG emissions in North Carolina.

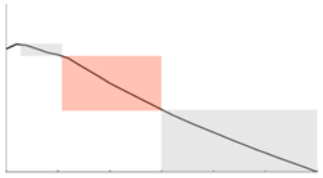


Roadmap to Net Zero: Near-term (2023-2025)



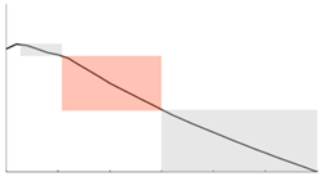
+ **The next few years should lay a solid foundation for clean electricity and widespread electrification:**
  - **Accelerate electric grid decarbonization**
    - Carbon Plan implementation
  - **Jumpstart electrification of light-, medium-, and heavy-duty vehicles and enhance the efficiency of the transportation system**
    - North Carolina Clean Transportation Plan; Executive Order No. 271; Federal Funding (e.g. NEVI)
  - **Electrify low-cost building space heating and water heating applications while maximizing energy efficiency in buildings**
    - Federal Funding; North Carolina Building Code Council
  - **Explore Additional Opportunities for Carbon Storage and Sequestration in North Carolina's Natural And Working Lands**
    - 2020 North Carolina Natural and Working Lands Action Plan
  - **Build on Pathways findings to ensure steady progress towards an affordable, equitable, and reliable net-zero future**
    - Conduct more analysis and engagement around environmental justice and economic impacts while developing a plan for monitoring progress towards climate targets and infrastructure deployments.

Roadmap to Net Zero: Mid-term (2025-2035)



- **To hit the state's 2030 goals and be on the right track for 2050 goals, North Carolina needs to achieve widespread decarbonization of electricity generation, transportation, and buildings:**
  - **Electricity Decarbonization** passing through 70% reductions in CO2 emissions by 2030 on a path to full carbon neutrality by 2050
    - HB 951 requirement to reduce GHG emissions from Duke Energy's electricity generation
    - Additional consideration for decarbonizing all electricity generation consumed in the state
  - **Transportation Decarbonization** to change over most older vehicles with cleaner alternatives when they come off the road
    - Sales of zero-emission light-duty vehicles should approach 100% sales of ZEV vehicles by 2035
    - Models of medium- and heavy-duty trucks that are electric or hydrogen fuel cells continue to be commercialized and will need to reach about a third of new sales by 2030
    - A robust network of EV charging infrastructure for personal vehicles and fleets and coordination with neighboring states will be required

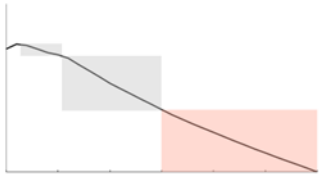
Roadmap to Net Zero: Mid-term (2025-2035), cont'd



- **Building Decarbonization** focusing on space heating and water heating
  - Updates of codes and standards to consider all-electric or carbon-neutral building standards in the 2030 timeframe
  - Deployment of more efficient and electric appliances in existing buildings up to 100% of sales by 2040
  - Integrated electric system planning that may include a role for hybrid heating systems for existing buildings

+ **Prioritize solutions for short-lived climate pollutants and research new technologies that have not yet reached commercial maturity:**
  - **Short-Lived Climate Pollutants** including methane and hydrofluorocarbons (HFCs)
  - **Research Emerging Technologies** including
    - Commercialization of decarbonized fuels such as green hydrogen or advanced biofuels
    - Commercialization of negative emissions technologies such as direct air capture of CO2
    - Innovation in agriculture, waste, and industrial processes

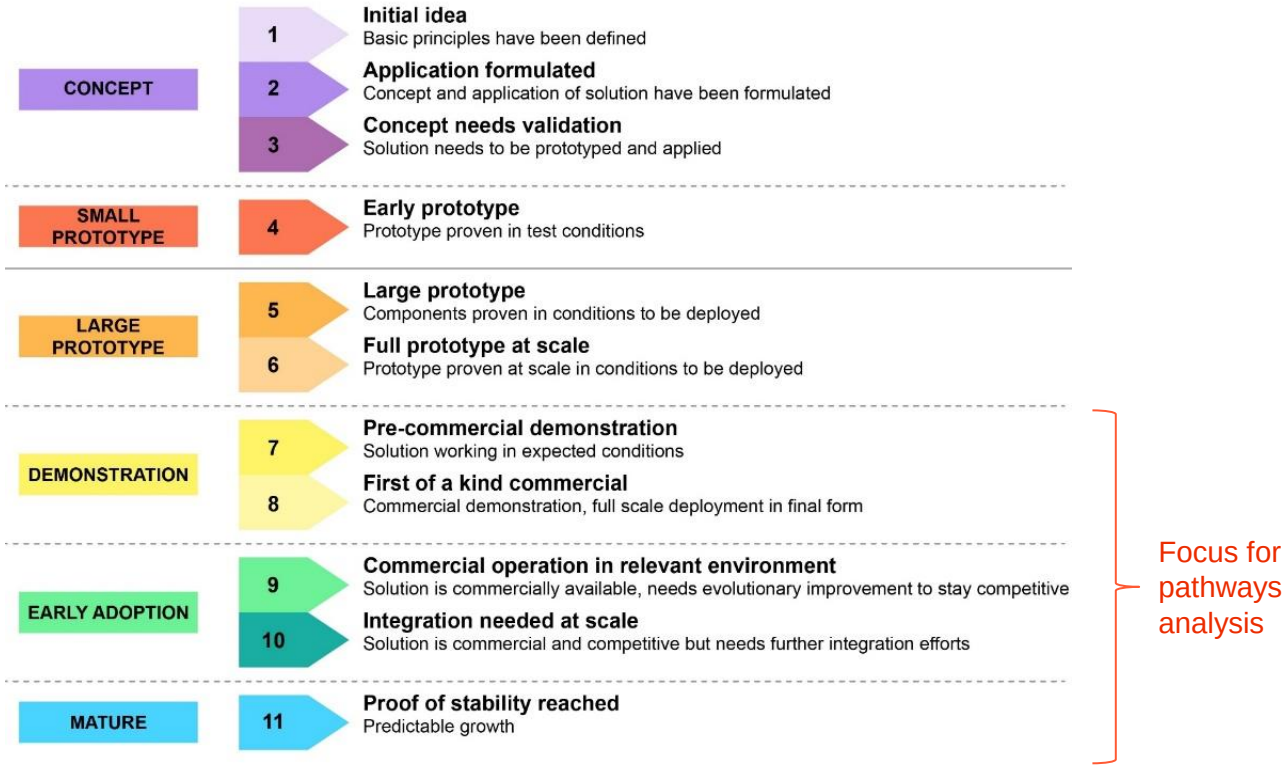
Roadmap to Net Zero: Long-term (2035-2050)



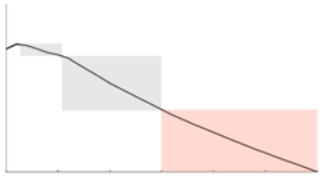
+ **After 2035, North Carolina will need to move to deploy the next phase of solutions, tackling some of the more challenging applications such as industry, agriculture, waste, and off-road transport applications**

+ **The International Energy Agency has developed a set of Technology Readiness Levels (TRLs) that measure the current state of commercialization of decarbonization measures**
  - This scale ranges from a 1 (initial conceptual idea) to 11 (mature technology with proof of stable and predictable growth).
  - Decarbonization pathways scenarios include technologies that are at least a level 7 (prototyped and at pre-commercial demonstration) to ensure that we do not rely on technologies that are too nascent

Technology Readiness Levels Scale from IEA



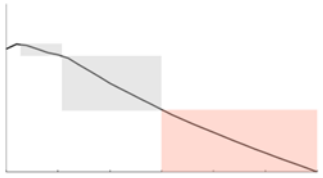
Roadmap to Net Zero: Long-term (2035-2050), cont'd



- Many technologies that could support a cost-effective transition to deep decarbonization are still in early stages of commercialization and deployment
- In particular, additional support will be needed to commercialize **large heat pump systems for commercial buildings** and **zero-emission heavy-duty vehicles**

Technology Readiness Levels (1/2)

Roadmap to Net Zero: Long-term (2035-2050), cont'd



- Research and development (R&D) will need to continue to support commercialization of **zero-carbon firm electric resources**, **green hydrogen**, **advanced biofuels** and **direct air capture (DAC)**
- In addition, North Carolina should continue to explore additional opportunities for **carbon storage and sequestration** in North Carolina's forests and soils.

Technology Readiness Levels (2/2)

How can you stay engaged?

+ Next Steps:

- The Pathways Analysis will be released in late January.
- The Cooper Administration will work to implement identified strategies and evaluate opportunities to complement, refine, and update the Pathways Analysis over time.

+ Feedback is welcome:

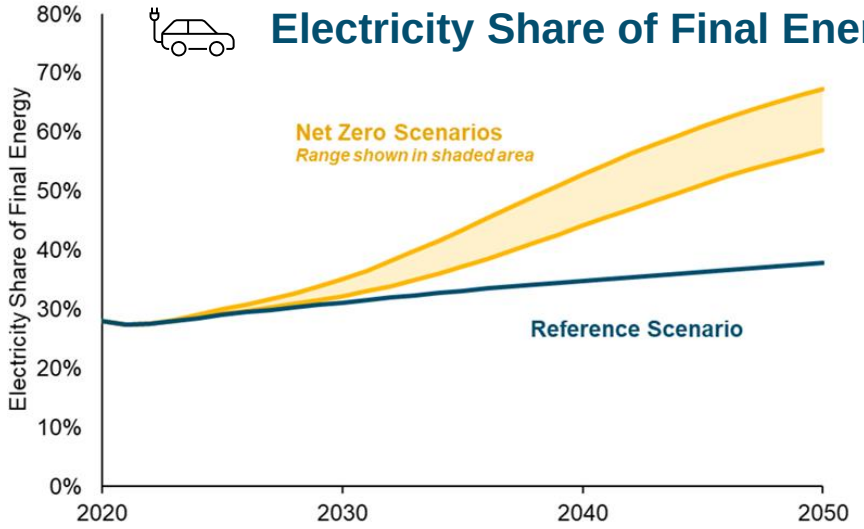
- What questions/comments do you have about the Key Findings or the Roadmap to Net Zero?
- What further analysis or considerations would complement or improve the Pathways Analysis?
- What decision-making venues should incorporate the findings of the Pathways Analysis?
- *Feedback can be submitted* on an ongoing basis to contactgov@nc.gov
- *Website to stay up to speed on the Pathways and learn more: https://governor.nc.gov/issues/environment*

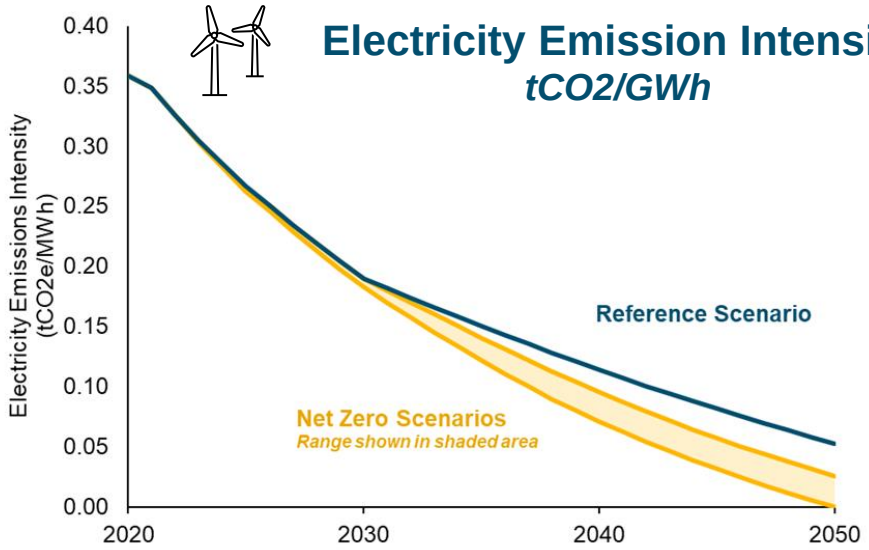
Appendix

Summary of Key Findings

Summary of Key Findings – 1/4

1. **Accelerate electrification of transportation** (zero-emission vehicles) **and buildings** (heat pumps, electric cooktops, etc.)
   - Electricity becomes the foremost fuel powering the economy, meeting 60%-70% of all energy demand
2. **Rapidly decarbonize electricity generation** by scaling up renewable electricity sources and battery storage
   - Emissions intensity of electricity generation decreases by 93%-100% by 2050





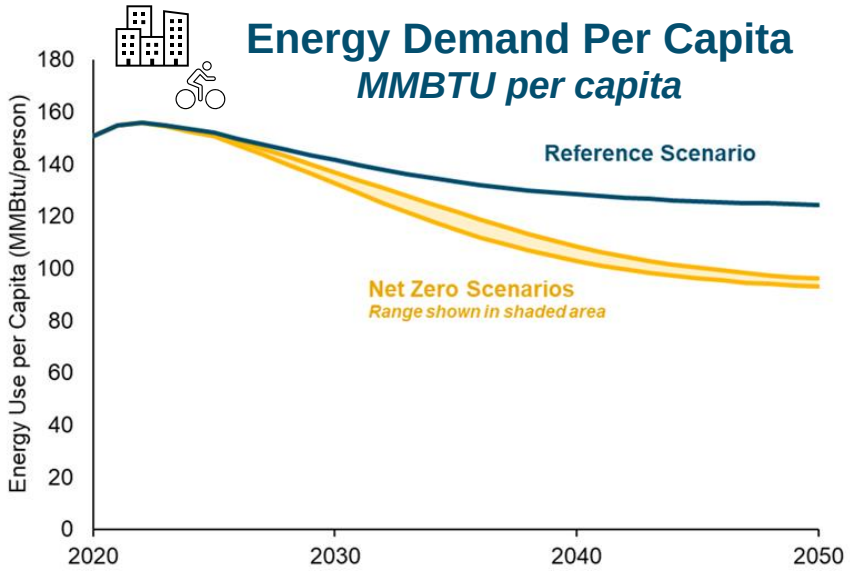
Summary of Key Findings – 2/4

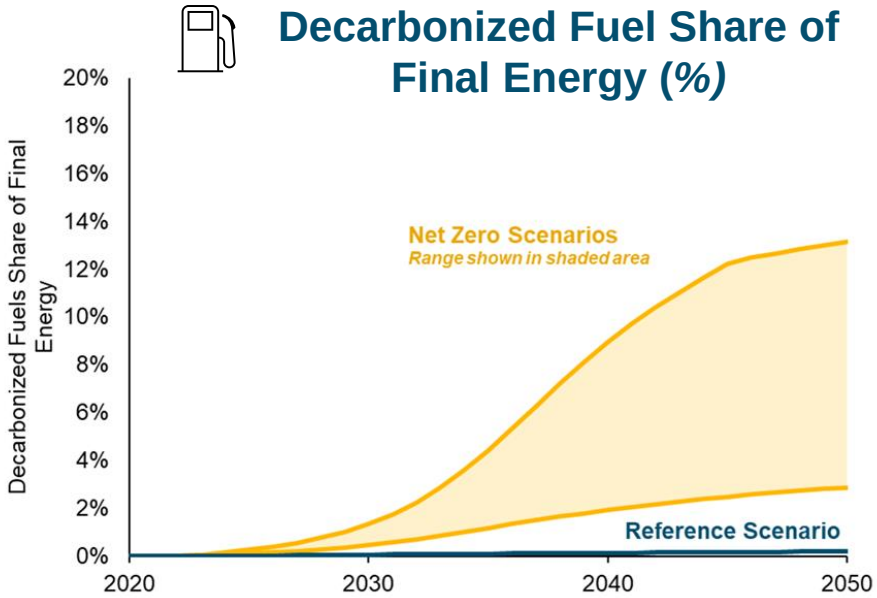
3 **Encourage high levels of energy efficiency**, such as adoption of efficient appliances and vehicles, improvement of building shells, and reduction in VMT

- Energy use per capita decreases by ~45% by 2050, while meeting the same services
- Electric vehicles and heat pumps can be 3-4x as efficient as current fossil-powered options

4 **Support commercialization of decarbonized fuels,** at a minimum to green hydrogen for industry and large trucks, but also potential for advanced biofuels using sustainable biomass feedstocks

- Decarbonized fuels serve a critical but targeted role for hard-to-electrify sectors, reaching 3%-12% of energy demand





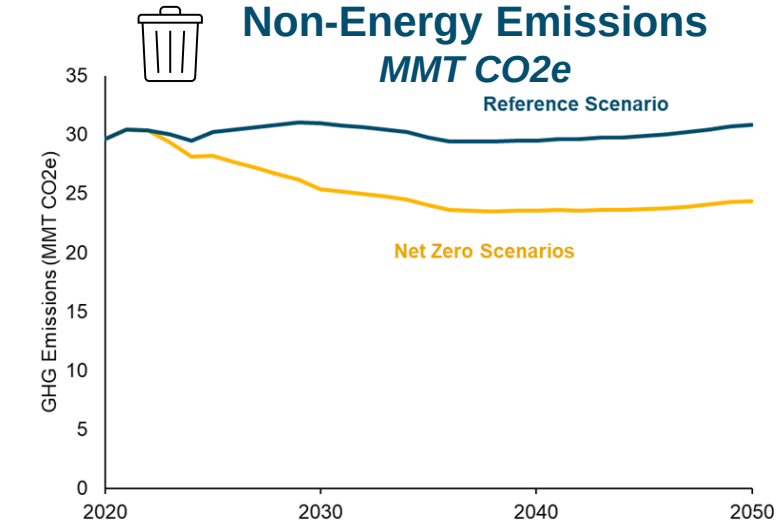
Summary of Key Findings – 3/4

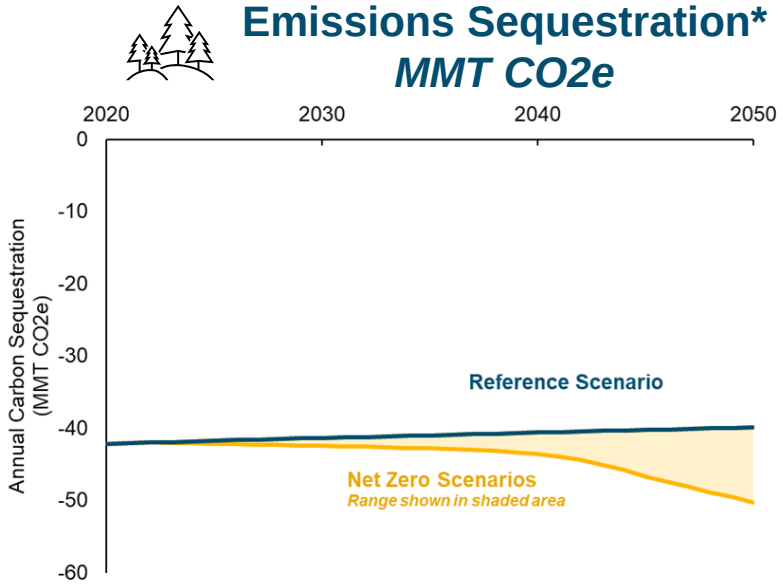
5 **Implement strategies to reduce non-energy greenhouse gas emissions** from industry, agriculture, waste, and oil and gas systems

- These sectors are some of the most challenging to mitigate at reasonable costs, but can achieve 12% reductions in 2050 vs. the Reference trajectory

6 **Prioritize sustainable management of natural and working lands** to enhance the critical role of carbon sequestration in helping achieve net zero emissions

- North Carolina's natural carbon sink plays a critical role and when combined with Direct Air Capture can lead to an additional 10 MMT of annual sequestration in 2050





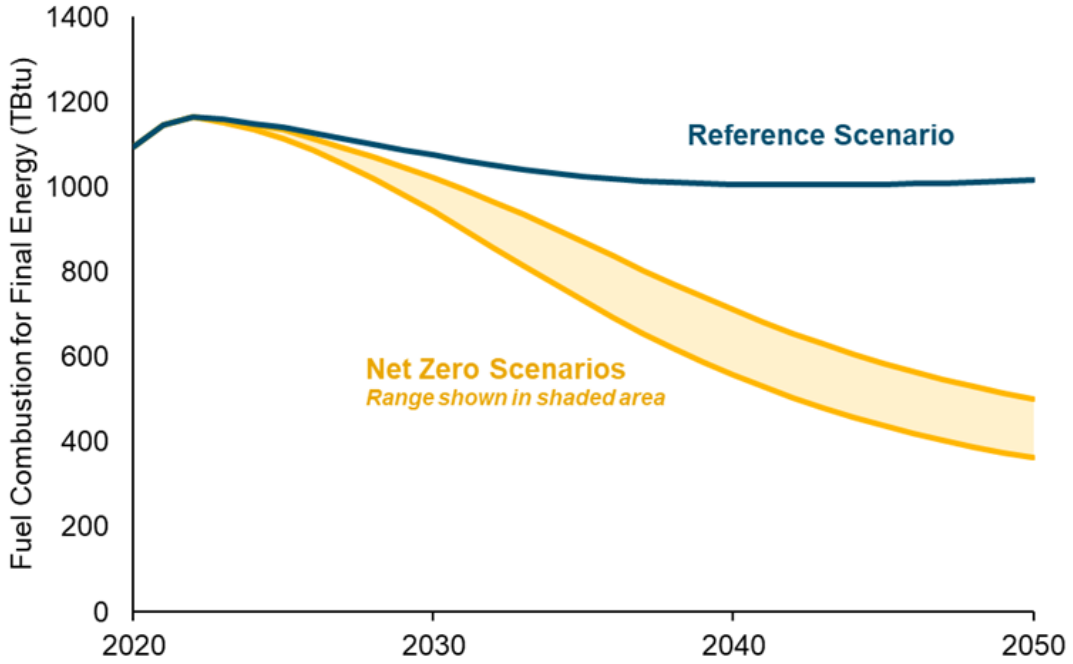
*Includes emission sequestration from natural and working lands, as well as negative emission technologies such as Direct Air Capture (DAC)

Summary of Key Findings – 4/4

7 **Reduce fuel combustion while decarbonizing the economy to create co-benefits for air quality improvement,** especially in disadvantaged communities that have been historically disproportionately impacted by vehicle emissions

- Petroleum combustion is reduced ~80% by 2050 vs. today, natural gas combustion is reduced 50-70%, and coal combustion in industry is reduced by 100%

Total Fuel Combustion* - *TBtu*



*Renewable petroleum and renewable natural gas are included in combustion totals due to similar air pollution impacts of these fuels