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Zero-Emission Vehicle Emissions Estimation Method Refinements

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Acronyms

ACT – Advanced Clean Truck
AVFT – Alternate Vehicle Fuel and Technology
BEV – Battery Electric Vehicle
DEQ – Department of Environmental Quality
DOT – Department of Transportation
EGU – Electricity Generating Unit
EO – Executive Order
EV – Electric Vehicle
FCEV – Fuel Cell Electric Vehicle
IRP – Integrated Resource Plan

Acronyms

MOVES - MOtor Vehicle Emission Simulator
MY – Model Year
NC – North Carolina
GHG – Greenhouse Gas
SIT – State Inventory Tool
TDM – Travel Demand Model
VIUS – Vehicle Inventory and Use Survey
VMT – Vehicle Miles Traveled
ZEV – Zero-Emitting Vehicle

North Carolina Greenhouse Gas (GHG) Emissions Inventory

- Executive Order (EO) 80 - Inventory as Starting Point for Planning
- Current NC Inventory Published in 2022
- Comprehensive/Economy-Wide
- 1990-2030 (historical estimates: 1990-2018; projected estimates: 2019-2030)
- Identifies Key Sectors in NC: Transportation Became Top-Emitting Sector in 2016

North Carolina GHG Emissions Estimation

- EPA's State Inventory Tool (SIT) - Comprehensive, State-Level, Updated Annually
- Deviations from SIT Included Onroad Vehicles
  - EPA MOVES3 model
  - Replacement of MOVES defaults – Vehicle Miles Traveled (VMT) data
    - Historical Data – disconnects in historical time-series
    - Forecast Data – use of Travel Demand Model (TDM)-based estimates where available and use of historical VMT estimation equation based on explanatory variable(s) for non-TDM areas

North Carolina GHG Emissions Estimation

- Deviations from SIT Included Onroad Vehicles (cont'd)
  - Post-Processing of MOVES output: project Battery Electric Vehicle (BEV) penetration
    - Started with local utility's base case EV projections from 2020 Integrated Resource Plan (IRP)
    - Projected annual light-duty BEVs sales and VMT within Duke Energy service areas (83 counties), scaled to 100 counties
    - Forecast: expected to meet EO 80 goal of 80,000 zero-emission vehicles (ZEVs) by 2025
  - Electricity Demand GHG Emissions Forecast Reflects BEV projections

North Carolina Executive Orders 246 and 271

- **EO 246**, "North Carolina's Transformation to a Clean, Equitable Economy"
  - Reduce GHG emissions to at least 50% below 2005 levels by 2030 and achieve net-zero emissions as soon as possible, no later than 2050
  - Requires updated GHG Inventory/Forecast every 2 years (next in 2024)
  - Goal to increase total number of registered ZEVs to at least 1,250,000 by 2030 and reach 50% of NC sales of new vehicles as ZEVs by 2030
- **EO 271**, "Growing North Carolina's Zero-Emission Vehicle Market"
  - DEQ to consider establishing a North Carolina Advanced Clean Trucks (ACT) program requiring manufacturers to sell an increasing percentage of medium- and heavy-duty ZEVs over time

North Carolina Onroad Vehicle ZEV Policy Analysis

- Estimating Emission Reductions from Potential ZEV-Related Policies
  - EPA onroad vehicle GHG emission standards
  - State policies (e.g., adoption of ACT rule, other policies to increase ZEV penetration)
  - What are incremental reductions of state policy relative to EPA's proposed GHG emission standards?
- MOVES Modeling Approach
  - Key model inputs
    - VMT data
    - Vehicle population and battery and fuel cell electric vehicle (FCEV) sales penetration (Alternate Vehicle Fuel and Technology, AVFT table) by size class/model year (MY)

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North Carolina Onroad Vehicle ZEV Policy Analysis

- MOVES Modeling Approach (cont'd)
  - Historical data: State-specific best estimates to replace MOVES default inputs
    - Vehicle population estimates by size class/MY from State registration data
  - Forecast data: State-specific best estimates to replace MOVES default inputs
    - Travel demand model-based VMT estimates
    - BEV/FCEV future year sales (e.g., local electric utility plans)
- Post-Processing
  - Proportion of VMT from out-of-State vehicles by size class/MY (unaffected by in-State ZEV policies)
  - Estimation of EV-related electricity generation emissions

Policy Analysis MOVES Modeling Considerations

- MOVES4 Version Released August 30
  - For consistency, analysis of policy target (e.g., U.S. Climate Alliance, NC's EO 246) may require recalculating previous modeled emission estimates
  - Vehicle Miles Traveled
    - Historical: review VMT used for 2005/other historical baseline year of policy analysis to ensure consistency with forecast years (e.g., Highway Performance Monitoring System VMT disconnect in 2009)
    - Forecast: Travel Demand Model-based estimates where available; consider pandemic's impacts on VMT

Policy Analysis MOVES Modeling Considerations

- MOVES4 Version Released August 30 (cont'd)
  - Vehicle population estimates by size class/MY (age distribution)
    - State registration data – Vehicle Identification Number (VIN) decoding
    - Uncertainty of vehicles within categories [e.g., Class 2a (6,001-8,500 lbs.) vs. Class 2b (8,501-10,000 lbs.)]
    - Categorizes some trucks into larger vehicle size to match emission standards/rates (reclassified diesel light-heavy-duty Class 3 engine-certified vehicles for MY 2017 and later years as Class 4/5 vehicles)

Policy Analysis MOVES Modeling Considerations

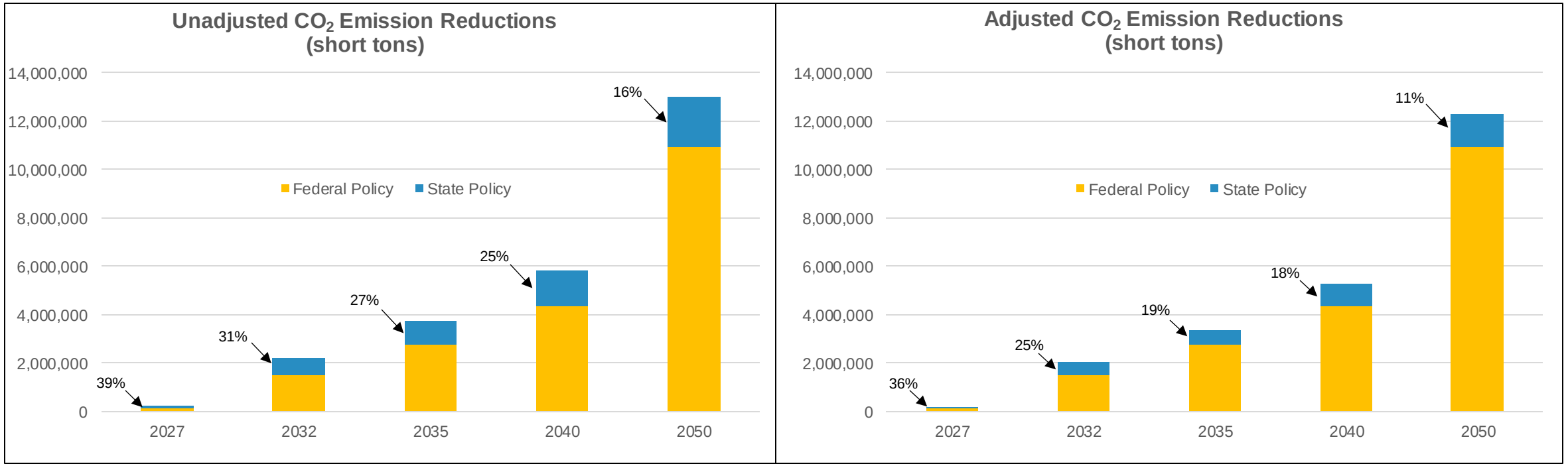
- MOVES4 Input Assumptions
  - Future year EV sales penetration assumptions (via AVFT table)
    - Baseline: review EPA default projections and AVFT tool options, compare to electric utility EV forecasts (IRP), and model impacts of any existing State policies not reflected in either
    - Post-Policy: update AVFT's battery EV and fuel cell EV sales penetration by MY
- Post-Processing MOVES Output
  - Proportion of in-State registered vehicles first purchased in-State by size class/MY

Policy Analysis MOVES Modeling Considerations

- Post-Processing MOVES Output (cont'd)
  - Potential sources characterizing in-State vehicles
    - Vehicle Inventory and Use Survey, VIUS (2021 VIUS in Fall of 2023)
    - International Registration Plan
  - EGU emissions estimation – apply projected EGU emission rates to EV consumption estimates from MOVES output
- Other Refinements
  - Class size/age distribution/VMT changes due to EV penetration?
  - Model State policy incremental to adoption of EPA proposed GHG standards

Example Results – Vehicle CO_2 Emission Reductions

Proportion of State Policy Reduction Relative to Total Reduction (State + Federal Policy) for Medium/Heavy-Duty Vehicles



Unadjusted - MOVES run output
Adjusted - MOVES run output with in-State first purchase adjustments applied

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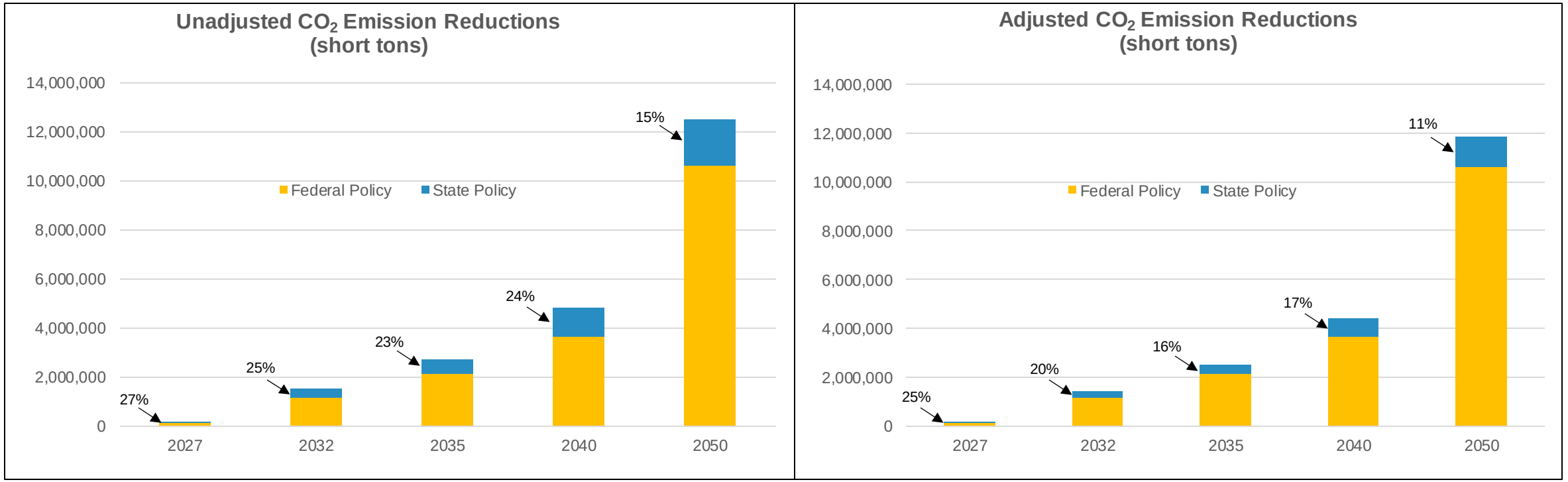
Example Results – Total CO_2 Emission Reductions

Proportion of State Policy Reduction Relative to Total Reduction (State + Federal Policy) for Medium/Heavy-Duty Vehicles



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