



SCHOOL OF  
PUBLIC POLICY

CENTER FOR GLOBAL  
SUSTAINABILITY



**Maryland**  
Department of  
the Environment

# Pathway to Maryland's GHG Reduction Goals

Mitigation Working Group Meeting  
May 18, 2023

# Agenda

- Project status update
- CSNA-compliant scenario
  - Modeled policies
  - Sectoral overview
  - Summary results
  - Sensitivity scenarios

# Project Status Update

- Current policies fully included in the model except for carbon sinks
- CSNA scenario meets 2031 goal of 60% gross emissions reductions
  - 2045 net-zero goal not yet met, but the June report will chart a path to net-zero
- June report will feature two core scenarios and three sensitivity scenarios:
  - Core: Current policies, CSNA
  - Sensitivities: low estimate of IRA impact, low implementation overall, net emissions
- Impact analysis: air quality improvements represented at the county level

# Modeling Methodology & Assumptions

- Using Global Change Analysis Model (GCAM-USA), which has 32 global regions and 50 state-level resolution in the USA. The model runs in 5-year time steps.
- CO<sub>2</sub> and energy consumption along with major sources of CH<sub>4</sub>, N<sub>2</sub>O, and F-gases are modeled at state-level
- Electricity trade in fifteen grid (NERC) regions
- Key inputs, GDP, population and technology assumptions are harmonized with Annual Energy Outlook

# Current Policies Scenario

- Key policies included:
  - a. **Power:** RPS\*, RGGI\*, Planned coal retirements, IRA incentives
  - b. **Transport:** ACC II, ACT, IRA incentives, IIJA infrastructure funding, VMT reduction policies, CAFE standards\*
  - c. **Buildings/Industry:** EmPower, Building Energy Performance Standards, IRA incentives
  - d. **Non-CO2s:** AIM Act, MD natural gas methane regulations, MD HFC regulations, MD landfill methane regulations, IRA methane fee
  - e. **Other:** COVID impacts, GHG constraint on rest of states, Technology cost update
- To be added:
  - Tree Solutions Now Act

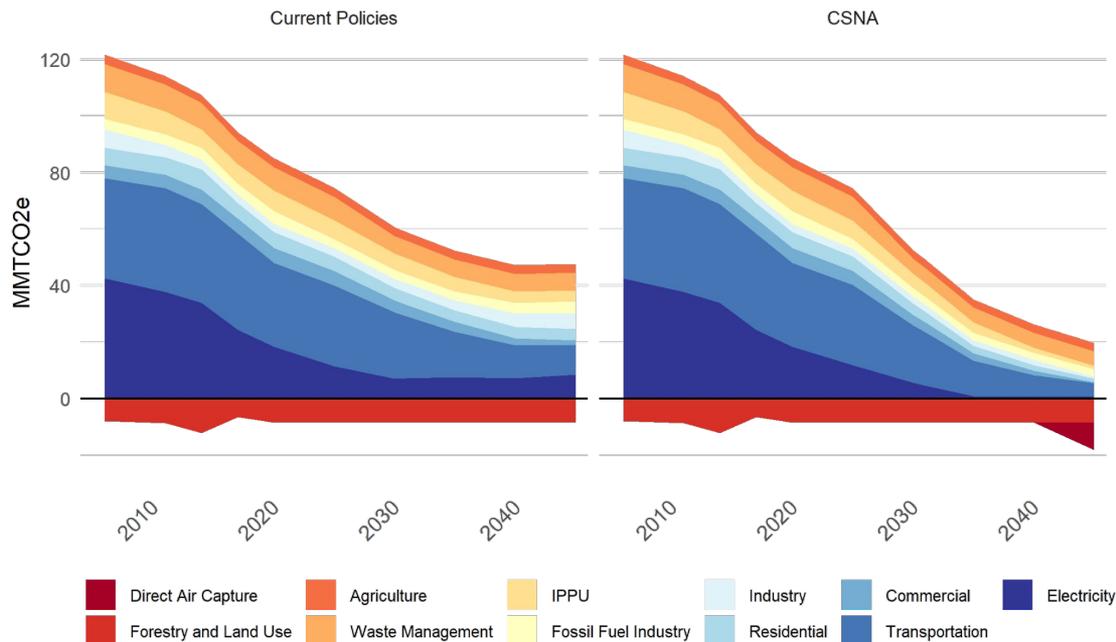
\*Note that these policies are implemented as they exist right now, not the new rules/regs being proposed. Anything that is passed into law will be addressed in the final version.

# Additional Policies in CSNA Scenario

- All current policies included
- Additional policies:
  - a. **Power:** RGGI cap reduced to net zero by 2040, Clean electricity standard of 100% by 2035
  - b. **Transport:** Advanced clean fleets, additional VMT reductions
  - c. **Buildings:** Zero emissions appliance standards, all-electric construction standards, strengthened energy efficiency standards
  - d. **Industry:** “Buy clean” standards to increase efficiency and electrification, fuel switching for cement & other industry, cement CCS
  - e. **Non-CO2s:** Methane reductions w/ marginal abatement cost curve for gas, waste, and agriculture
  - f. Cap and invest backstop policy to achieve remaining emissions
- To be added:
  - a. 100% electric bus sales by 2025

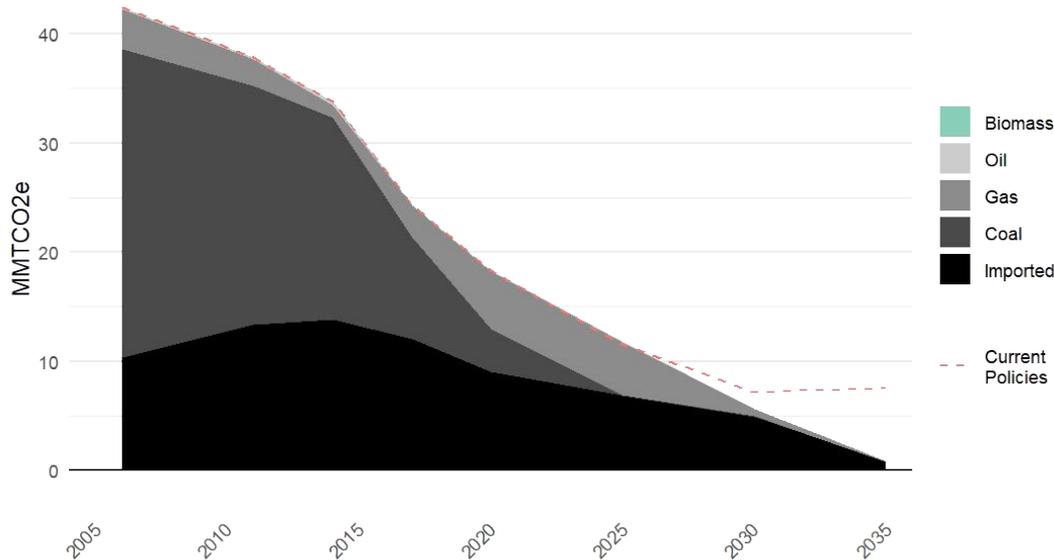
# Under CSNA scenario, economy-wide gross emissions reduce by 60% below 2006 levels by 2031

- Current policies achieve 50.9% reductions by 2031
- Emissions and sinks from Forestry and Land Use are held constant at 2020 levels
- Largest emissions reductions occur in the power sector, followed by transportation
- 2045 emissions almost reach net-zero, and will achieve the target in the final run
- Focusing on 2031 results today



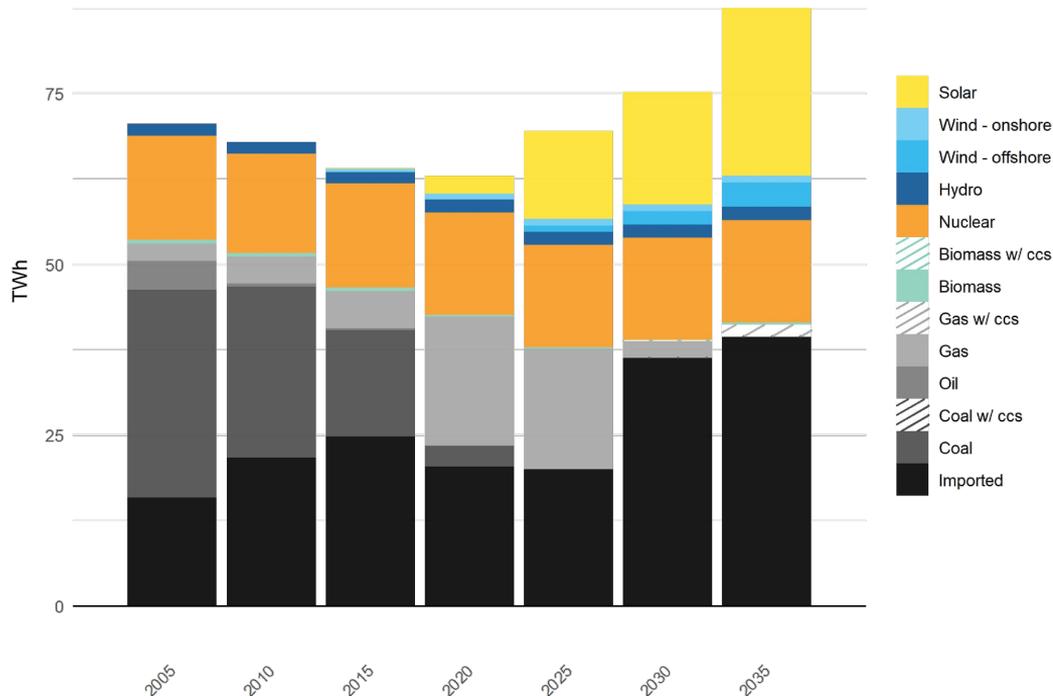
*Preliminary results*

# Electricity sector achieves over 88% reductions by 2031, with solar and wind rapidly replacing fossil technologies



- Gas and imports are the primary source of emissions
- Import behavior still being refined
- **Key policies included:**
  - Current RPS, planned coal retirements, IRA incentives
  - 100% clean electricity by 2035
  - RGGI goes to zero by 2040

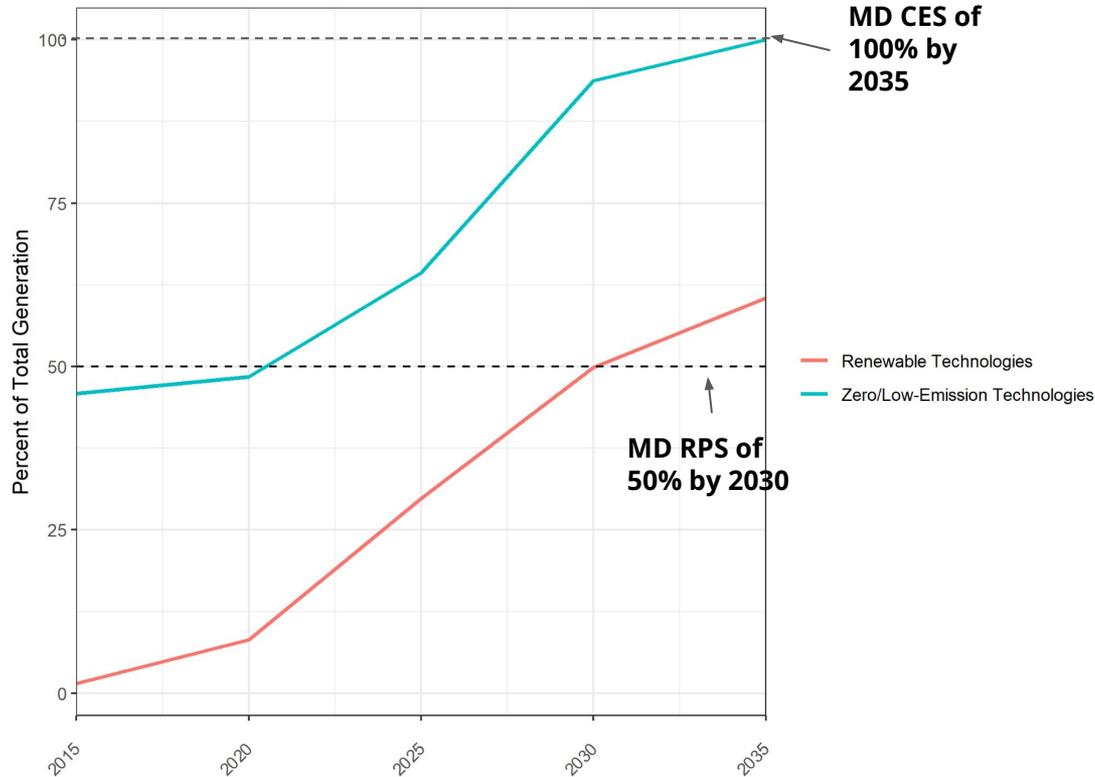
# Electricity sector achieves over 88% reductions by 2031, with solar and wind rapidly replacing fossil technologies



- Import behavior, and split between solar and wind are still being refined
- **Key policies included:**
  - *Current:* RPS, planned coal retirements, renewal of nuclear licenses, IRA tax credits
  - Coal retirements are based on EIA, EPA, and Global Energy Monitor databases, and announced retirements by coal companies
  - 100% clean electricity by 2035
  - RGGI goes to zero by 2040

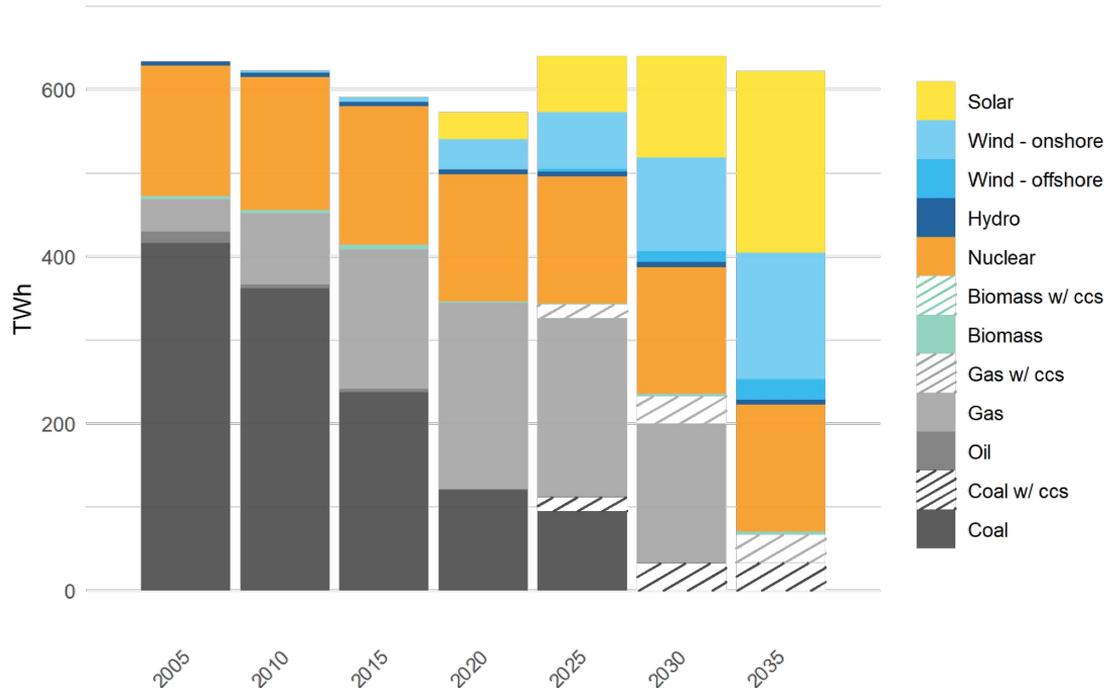
*Preliminary results*

# In-state generation reaches over 50% from renewable sources and over 93% from low emissions sources by 2031



- Zero/low-emissions sources include solar, wind, hydro, gas CCS, nuclear, and biomass.

# PJM states also have increasing renewable and low emissions sources in their grids



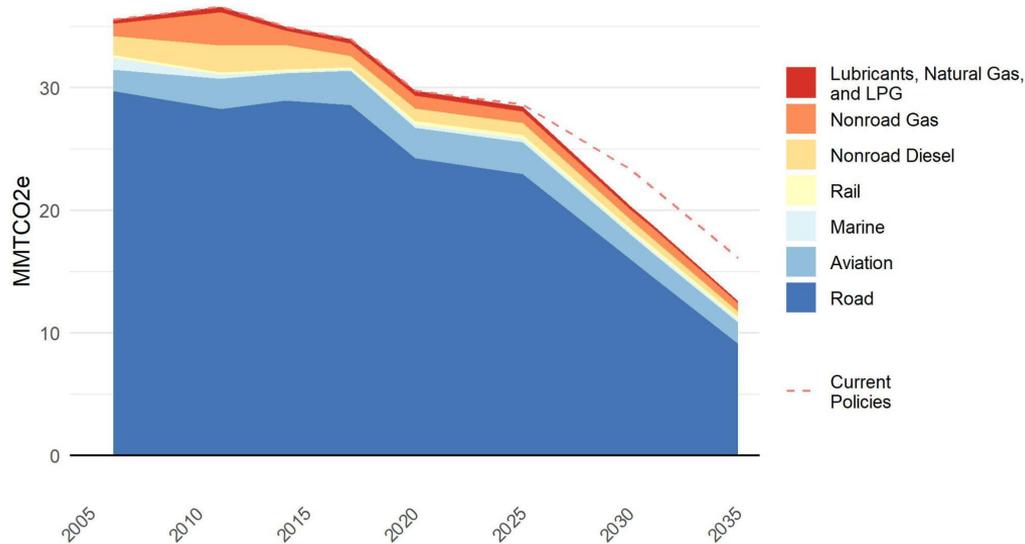
- Not a precise match for imported electricity because PJM boundaries don't align perfectly with state boundaries
- Still refining assumptions about PJM states

## Policies in PJM states include:

- *Current:* IRA tax credits, RPS, Emissions targets
- Accelerated coal retirements, RGGI

*Preliminary results*

# Transportation sector achieves 47% reductions, primarily through road vehicle electrification & efficiency measures



- Emissions matched to inventory sub-categories
- Road vehicles contribute to majority of reductions
- **Key policies included:**
  - *Current:* Advanced Clean Cars II, Advanced Clean Trucks, IRA tax credits, IIJA infrastructure funding, CAFE standards
  - Advanced Clean Fleets
  - VMT reductions from mode switching and smart growth, consistent with current ambition in leading states

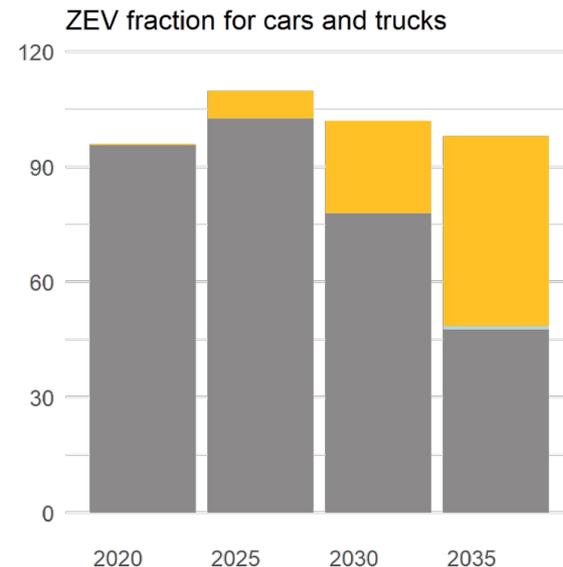
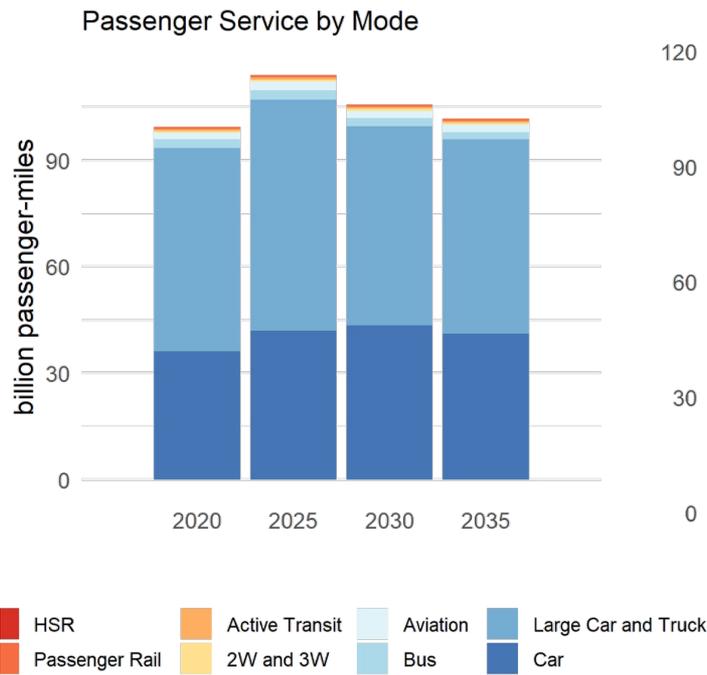
*Preliminary results*

# Breakdown of EV sales assumptions

- **Advanced Clean Cars II:** 15% EV sales by 2025, 54% by 2030, and 100% by 2035.
- **Advanced Clean Trucks:** 11-16% EV sales by 2025, 26-35% by 2030, 40%-55% by 2035
- **Advanced Clean Fleets:** 100% EV sales of freight trucks by 2045

# Passenger service declines over time with ZEV accounting for over half of road travel by 2035

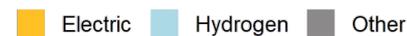
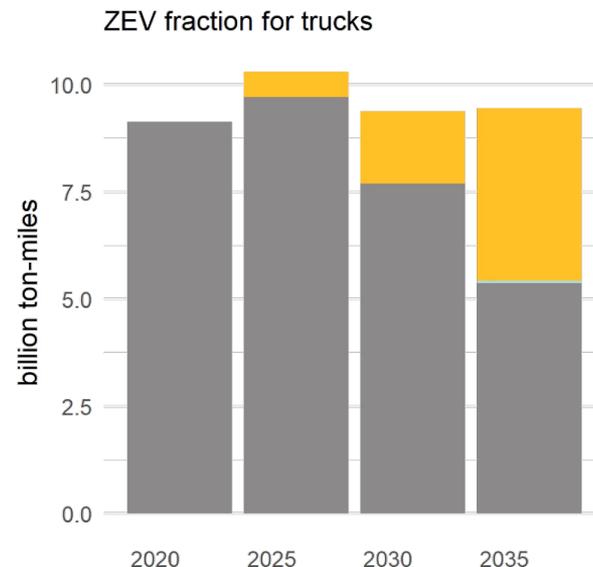
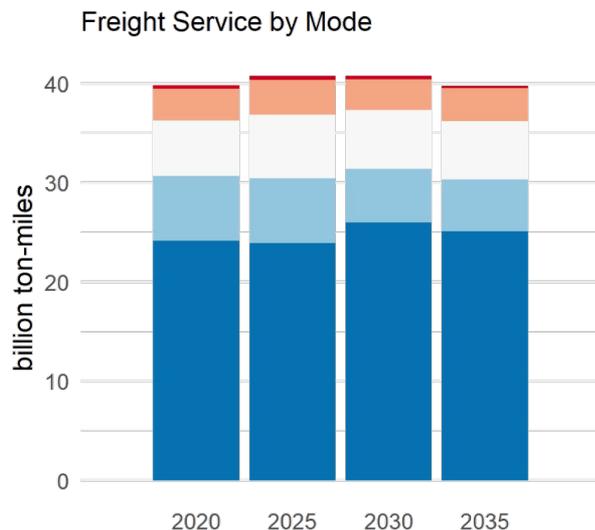
- Overall passenger service declines after 2025 due to VMT reduction policies
- Nearly 25% of car and truck passenger service is provided by zero emission vehicles by 2030
- Battery electric vehicles dominate passenger service



*Preliminary results*

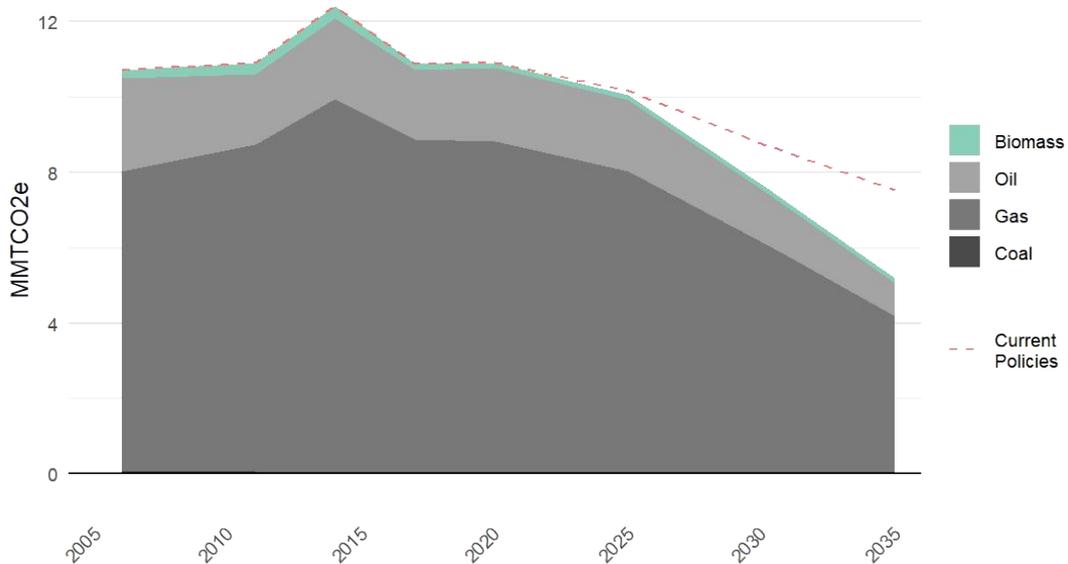
# Freight service stays fairly constant, but ZEV fraction of trucking expands rapidly

- Freight service stays fairly constant
- 18% of ton-km are delivered by zero-emission trucks by 2030
- Little role for hydrogen in meeting near-term target



*Preliminary results*

# Buildings sector achieves 33% reductions, through energy efficiency & electrification measures



- Residential sector sees larger emissions reductions than commercial sector
- Gas contributes to majority of emissions, decreasing over time

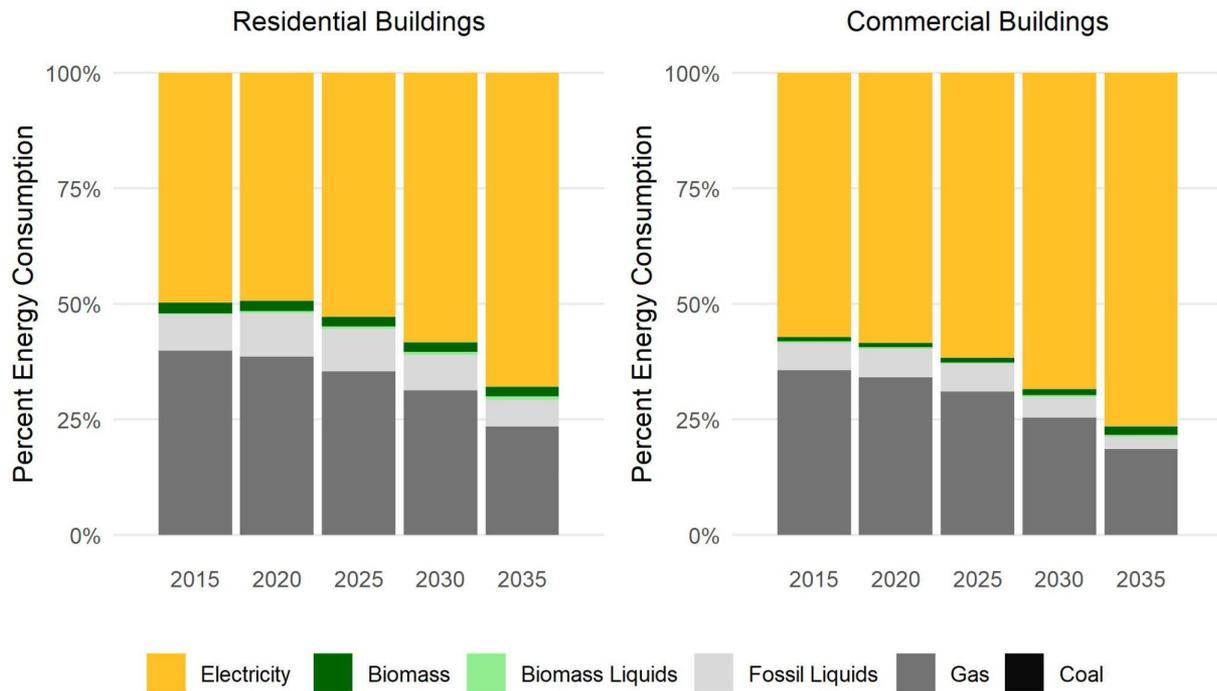
## Key policies included:

- *Current:* EmPower, Building Energy Performance Standards, IRA tax credits & rebates
- All electric construction standards starting in 2027
- Zero emissions appliance standards in line with San Francisco Bay Area's standards
- Extended energy efficiency standards beyond 2027

*Preliminary results*

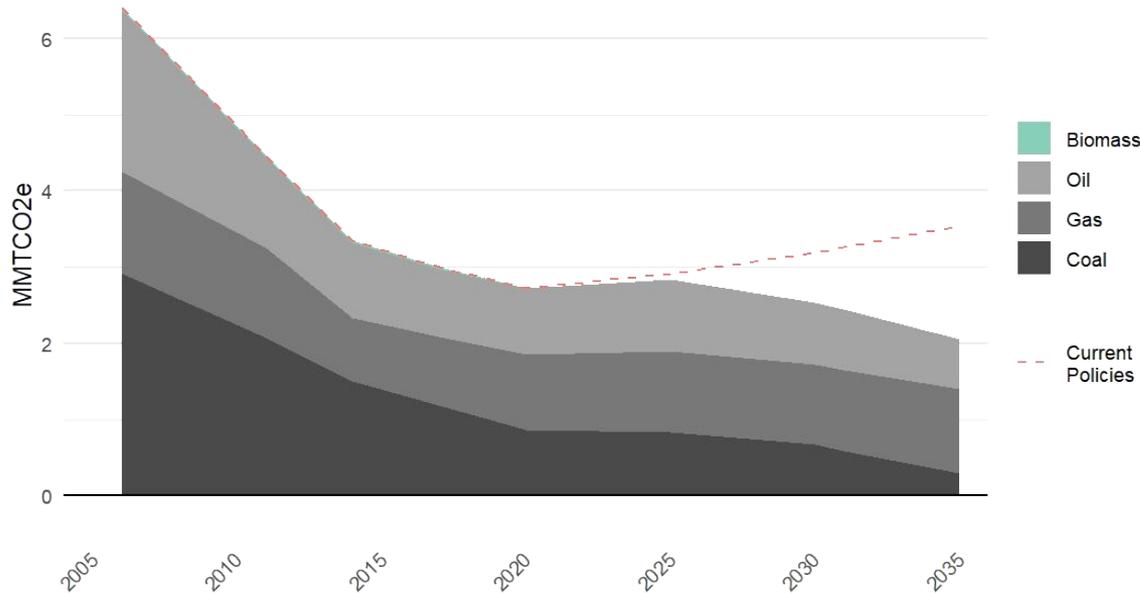
# Electrification increases in both commercial and residential buildings

- Fossil fuels supply less than 25% of energy in commercial buildings by 2035



*Preliminary results*

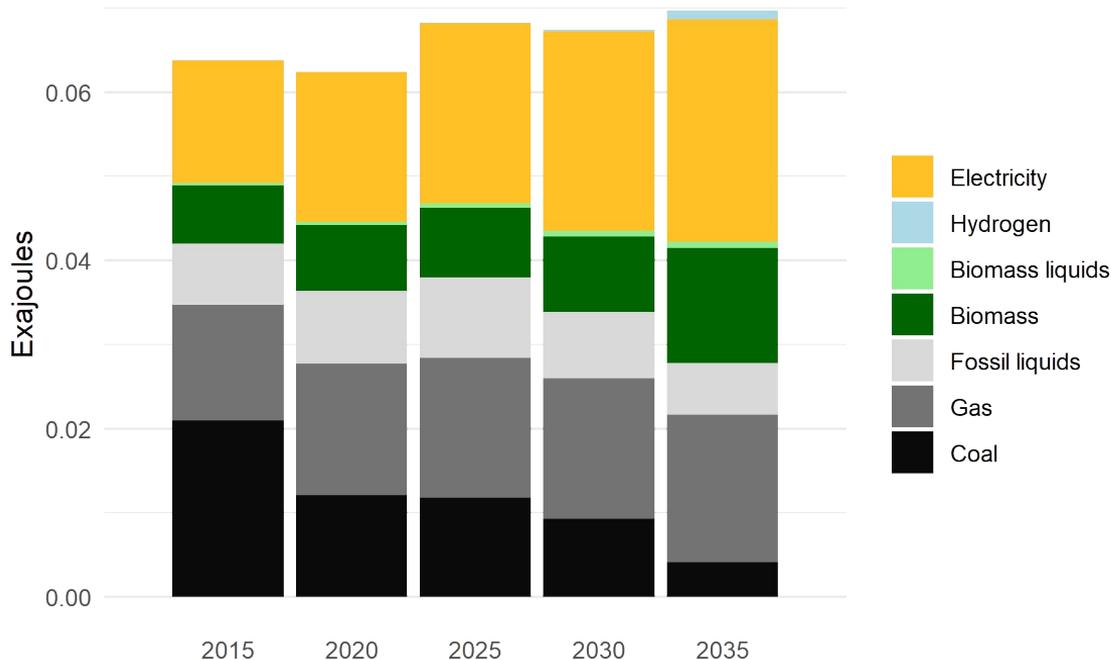
# Industrial sector achieves 62% reductions below 2006 levels in 2031



- **Key policies included:**
  - *Current:* IRA hydrogen tax credits, 45Q credits for CCS
  - Fuel switching from coal to natural gas
  - “Buy Clean” standards to increase electrification, efficiency, CCS
  - Included under cap and invest
- Additional policies would require removing the manufacturing exemption

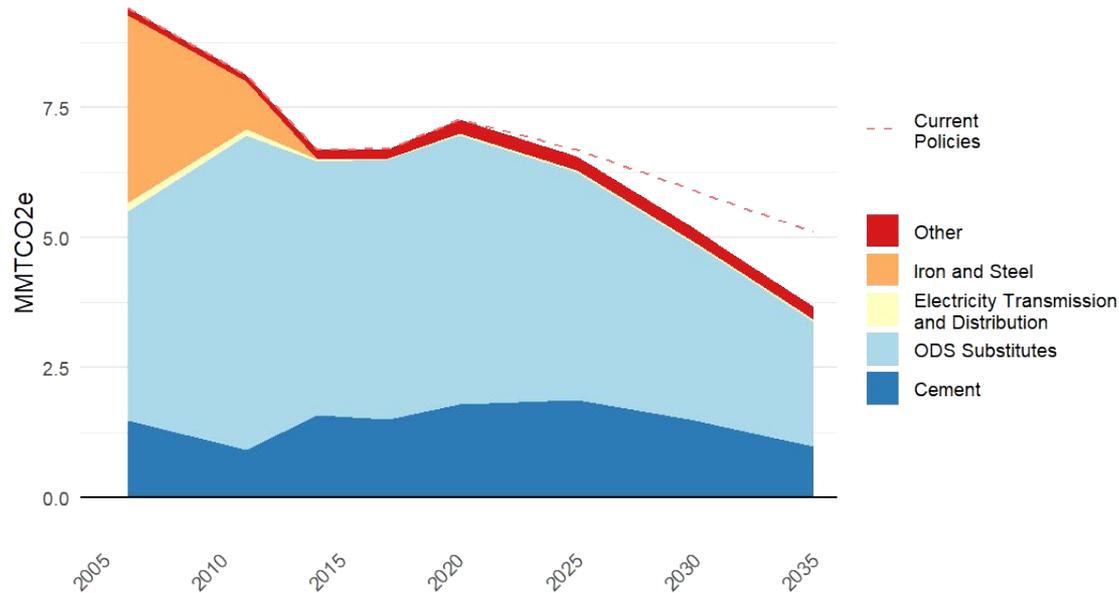
*Preliminary results*

# Industrial fuel use stays roughly constant overall, with increasing fraction of electrification



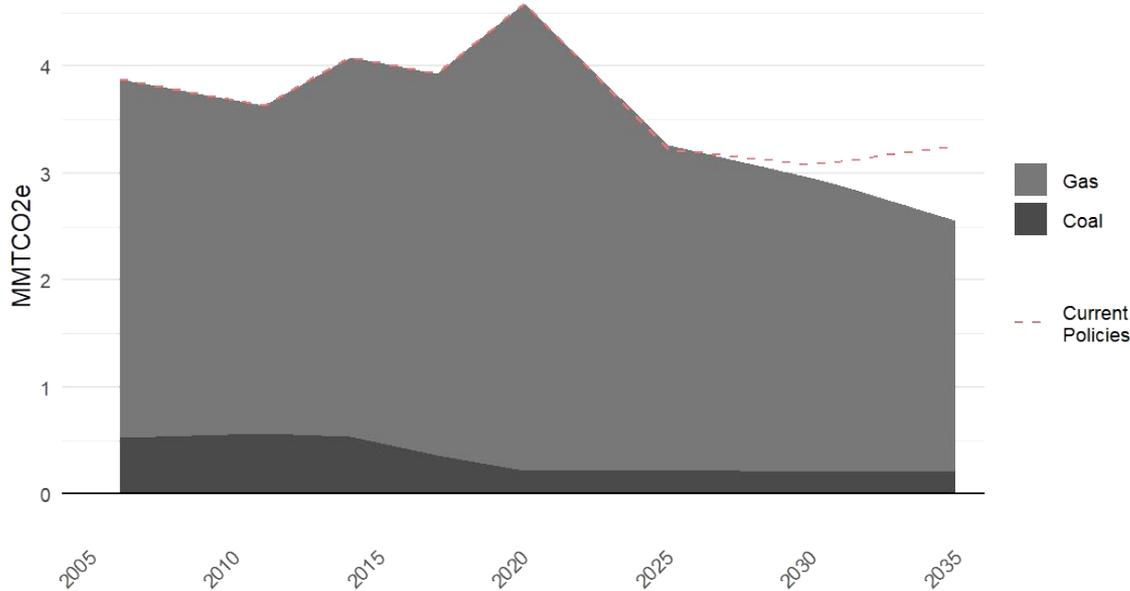
- Fossil fuel consumption remains level, indicating a reversal of demand growth
- Biofuels and biomass play a bigger role in later years
- Coal decline largely due to coal-to-gas switching in cement

# Industrial Processes and Product Use (IPPU) achieves 48% reductions in 2031



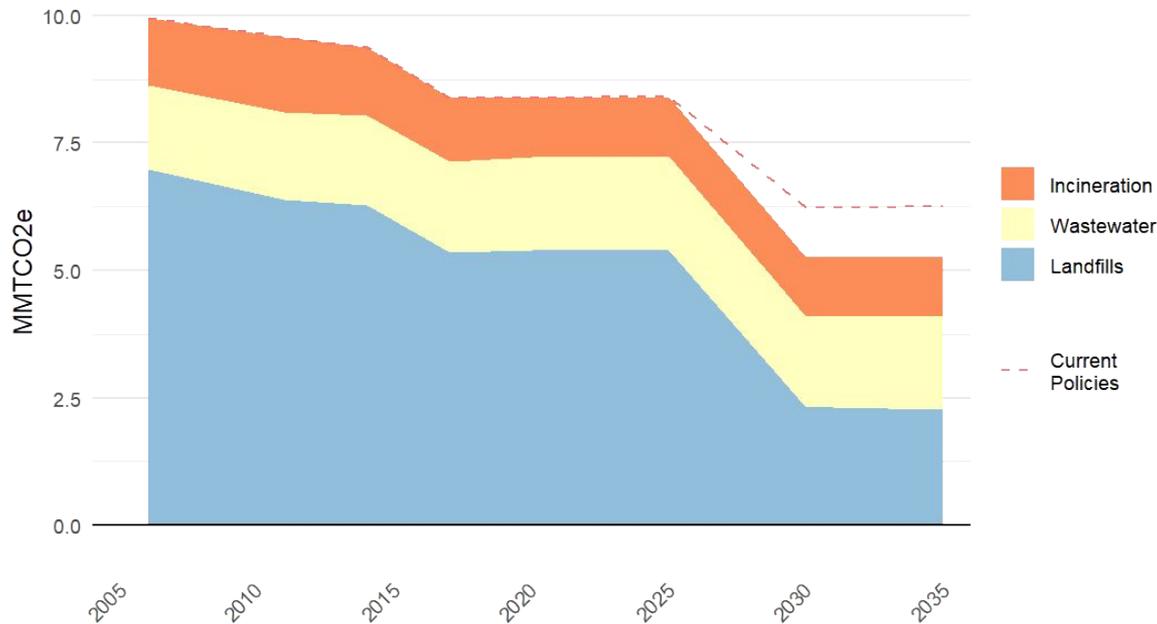
- Emissions from substitutes for ozone-depleting substances (ODS) decrease
- **Key policies included:**
  - *Current:* AIM Act, MD HFC regulations, 45Q tax credits
  - Cement CCS

# Fossil Fuel Industry achieves 26% reduction in 2031



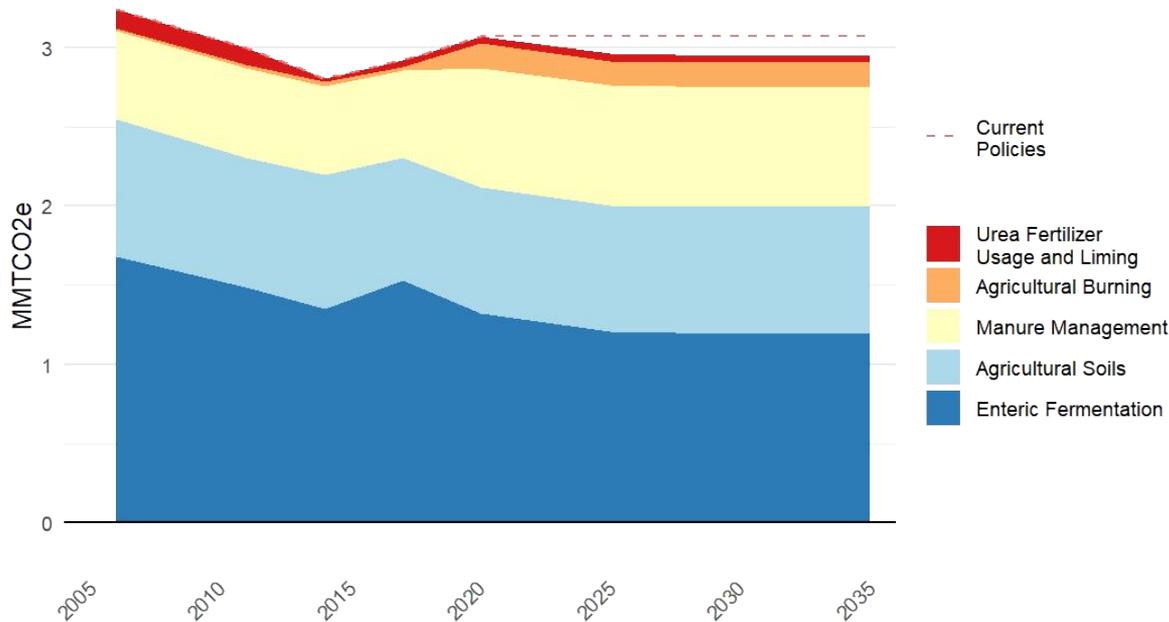
- Baseline projection from 2020-2050 is driven by MD gas consumption from GCAM
- **Key policies included:**
  - *Current:* MD gas methane regulations, IRA methane fee on 2 facilities
- Large reduction in MD gas consumption drives difference between Current Policies and CSNA scenarios, not additional policies in this sector

# Waste Management achieves 47% reductions in 2031 through methane reductions



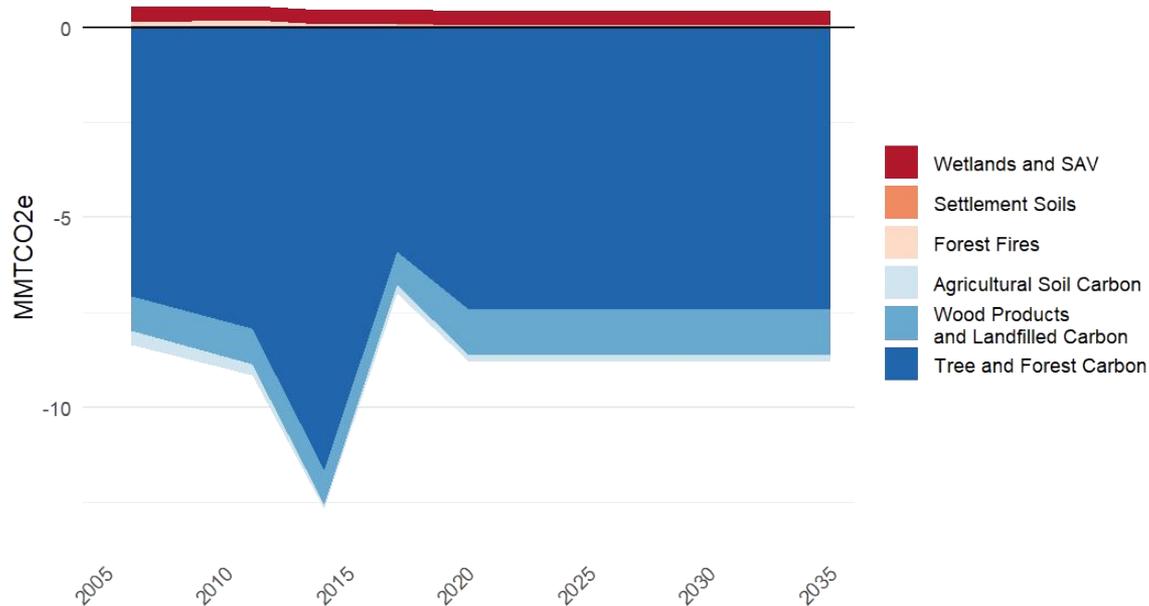
- Baseline projection from 2020-2050 assumed to be constant from 2020 due to waste diversion offsetting higher waste generation from population growth
- **Key policies included**
  - *Current*: MD landfill regulations (assume average of min. & max. estimated reductions)
  - In CSNA scenario, assume maximum estimated reduction

# Agriculture achieves 9% emissions reductions in 2031 with zero-cost actions



- Baseline projection from 2020-2050 assumes no net change in livestock population (i.e., constant emissions)
- **Key policies included**
  - No current policies scenario for livestock
  - In CSNA scenario, assume that reductions achievable in livestock at <\$0 from the EPA's marginal abatement cost curve for MD are achieved

# Forestry & Land Use currently held constant after 2020



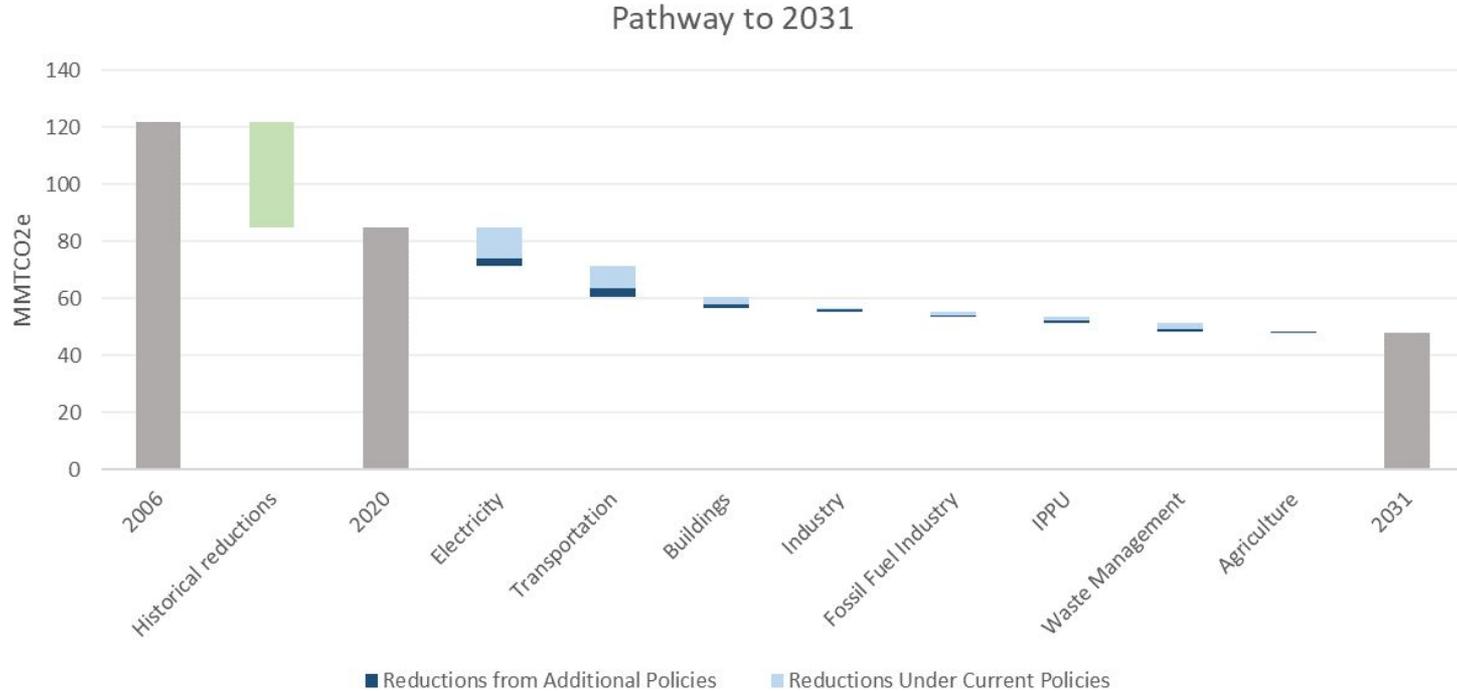
- Carbon sinks not relevant for 2031 gross emissions goal, but important for net-zero
- Currently held constant at 2020 levels, but will incorporate a projection for forest sinks
- **Key policies to be included:** Tree Solutions Now Act

# All sectors play a crucial role in reaching 60% reductions, but distribution is uneven across sectors

Percent emissions reductions achieved by 2031	
<b><i>Economy-wide</i></b>	<b>60%</b>
Transportation	47%
Electricity	89%
Buildings	33%
Industrial	62%
IPPU	48%
Fossil Fuel Industry	26%
Waste Management	47%
Agriculture	9%

- Largest reductions come from the electricity sector
- Transportation reductions are large in MMTCO<sub>2e</sub>, but relatively low as a percent-change compared to other sectors
- Agriculture contributes relatively little to reductions, but is a smaller sector overall

# Summary of emissions reductions by sector



*Preliminary results*

# Summary of key high-impact policies needed to reach the state targets

## Current policies:

- 50% RPS by 2030
- ACC II
- ACT
- Building Energy Performance Standards
- Natural gas methane regulations

## Additional policies:

- 100% CES by 2035
- RGGI goes to zero by 2040
- Zero emissions appliance standards
- VMT reductions from smart growth, mode switching
- Cap and invest

# Sensitivity Scenarios

- Low estimate of IRA impact
  - Currently assuming full implementation of IRA
- Low implementation of state policies
  - Incomplete implementation of federal and state policies leading to fewer reductions across all sectors
- Net emissions accounting for 2031
  - Allow counting of sinks toward 60% reduction goal



SCHOOL OF  
PUBLIC POLICY

CENTER FOR GLOBAL  
SUSTAINABILITY

# Thank you!

**Dr. Kathleen Kennedy**, Assistant Research Professor, Center for Global Sustainability, University of Maryland School of Public Policy

**Alicia Zhao**, Research Manager, Center for Global Sustainability, University of Maryland School of Public Policy

**Kowan O'Keefe**, PhD Candidate, Research Assistant, Center for Global Sustainability, University of Maryland School of Public Policy

**Dr. Steve Smith**, Senior Fellow, Center for Global Sustainability, University of Maryland School of Public Policy;  
Earth Scientist, JGCRI/PNNL

**Prof. Ryna Cui**, Assistant Research Director, Center for Global Sustainability and Assistant Research Professor, University of Maryland School of Public Policy. [ycui10@umd.edu](mailto:ycui10@umd.edu)

**Prof. Nate Hultman**, Director, Center for Global Sustainability and Professor, University of Maryland School of Public Policy.  
[hultman@umd.edu](mailto:hultman@umd.edu)