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TECHNICAL APPENDIX

# U.S. Climate Pathways for 2035 with Strong Non-Federal Leadership

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This Technical Appendix is based on the Technical Appendix for our recent report: *Toward 2035: Forging a High-Ambition U.S. Climate Pathway*.

## 1. Overview of Modeling Approach

Our analysis uses a version of the open-source Global Change Analysis Model (GCAM) to estimate the aggregate impact of federal and non-federal climate policies and actions on economy-wide emissions reductions in the United States. Specifically, we use GCAM-USA, a state-level version of GCAM. We refer to the version of GCAM-USA used in this study as GCAM-USA-CGS, which is based on the [open-source release](#) of GCAM-USA 6.0. GCAM-USA-CGS has been updated for the purposes of this study to reflect changes such as the most recent estimates of future renewable energy [costs](#) and non-CO<sub>2</sub> marginal abatement [costs](#).

## 2. Scenarios

Four scenarios covering a range of federal climate ambitions, coupled with enhanced climate action from non-federal actors, are modeled in this analysis. The range of federal climate ambitions, from low to high, includes: executive and legislative rollbacks, executive rollbacks, maintaining existing policies, and federal re-engagement after 2028.

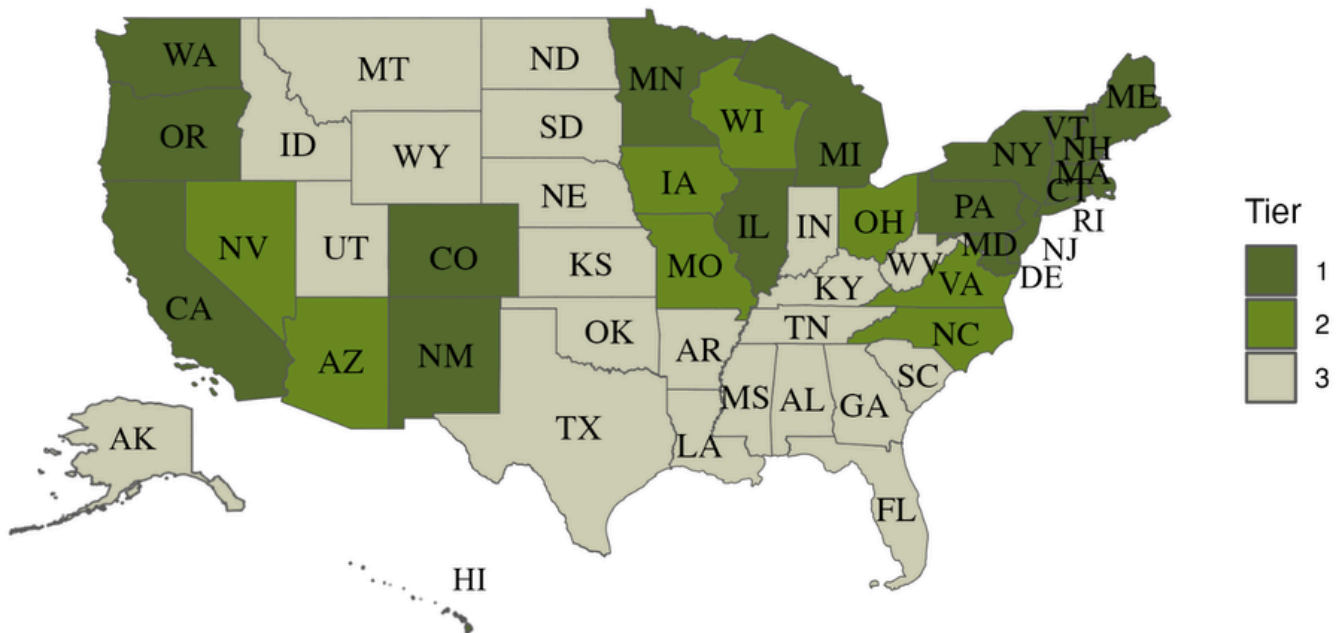
Policies that are rolled back are assumed to be repealed after 2025 and with few exceptions are rolled back completely. In reality, policies may not be rolled back completely or they may be replaced with weaker policies. Additionally, we assume that the federal government does not limit the ability of states to enact and implement climate policies. Under this assumption, the state of California continues to receive its waiver for clean air programs, and other states are able to adopt California's enhanced regulations. If the California waiver were to be overturned, it could complicate the ability of subnational governments to enact ambitious emissions reductions policies.

Details for federal climate ambition assumptions in each of these scenarios are described in section 4. Detailed assumptions for enhanced non-federal climate actions included in our scenarios are shown in section 5.

### 3. State Tiering

State-level climate action in the United States varies considerably across the country. For example, some states aim to achieve 100% ZEV sales in light-duty vehicle (LDV) markets by 2035, while other states have less ambitious ZEV sales targets, and some lack ZEV sales targets entirely. Therefore, to account for the unequal ambition and urgency with which states implement policies and actions to reduce emissions under enhanced ambition, we group states into three different tiers. This tiering approach reflects the propensity of a state to take further climate action based on the strength of its past and current climate policies. Tier 1 states have been leading the way on climate action in the United States and are assumed to adopt a full range of climate policies in deep decarbonization scenarios. Tier 2 states have some policies in place but tend to move slower than Tier 1 states on climate action, and are therefore assumed to adopt some of the additional climate policies, although at a slower rate than Tier 1 states. The rest of the states, categorized as Tier 3, have taken limited steps to advance climate action, and are assumed to continue at a slow pace, with limited additional policy action typically on slower time scales than assumed for Tier 1 and Tier 2 states. The categorization of states into the three tiers is shown below:

- **Tier 1 states:** California, Colorado, Connecticut, Delaware, the District of Columbia, Hawaii, Illinois, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington
- **Tier 2 states:** Arizona, Iowa, Michigan, Missouri, Nevada, North Carolina, Ohio, Virginia, and Wisconsin
- **Tier 3 states:** Alabama, Alaska, Arkansas, Florida, Georgia, Idaho, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Montana, Nebraska, North Dakota, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming



**Figure S1.** Categorization of states into Tier 1, Tier 2, and Tier 3.

## 4. Federal Assumptions

**Table S1.** Modeled federal policies across a range of federal ambitions. For detailed descriptions about how specific policies were modeled in GCAM-USA-CGS, see our previous analysis [here](#).

Policy type	Policy	Federal ambition (low to high)			
		Repeal existing regulations + legislation	Repeal existing regulations	Maintain existing policies	Re-engage after the Trump administration
Federal legislation	IRA	Repealed after 2025	Maintained, expires as written	Maintained, expires as written	Maintained, then extended at full value through 2035. Additional methane fee for coal and waste sectors.
	BIL	Repealed after 2025	Maintained	Maintained	Maintained
	AIM Act	Repealed after 2025	Maintained	Maintained	Maintained
Federal regulations	Regulations for new gas and coal generation	Repealed after 2025	Repealed after 2025	Maintained	Maintained
	CAFE standards and GHG standards for LDVs	Repealed after 2025	Repealed after 2025	Maintained	Maintained, then enhanced after 2030
	Oil and gas methane regulations	Repealed after 2025	Repealed after 2025	Maintained	Maintained
	GHG emissions standards for freight trucks	Repealed after 2025	Repealed after 2025	Maintained	Maintained, then enhanced after 2030
	Standards on oil refineries	-	-	-	Introduced after 2030, requiring CCS capabilities for 25% of oil by 2035
Direct Air Capture	-	-	-	Achieve 12 MtCO <sub>2</sub> removals by 2035	

## 5. Non-Federal Assumptions

**Table S2.** Non-federal climate actions assumed in all modeled scenarios. For comparison, assumptions under the Current Policies scenario from our earlier report are provided. For detailed descriptions about how specific policies were modeled in GCAM-USA-CGS, see [here](#).

Policy Type	Sector	Current Policies Scenario	Modeled scenarios		
			Tier 1 States	Tier 2 States	Tier 3 States
Non-federal	Electricity – RPS	Current state-level RPS targets are modeled	Tier 1 states achieve RPS target of 75% and 95% zero-carbon by 2035	Tier 2 states achieve RPS target of 55% and 95% zero-carbon by 2035	Tier 3 states achieve RPS target of 55%
	Electricity - Cap and trade	The Regional Greenhouse Gas Initiative (RGGI) is modeled as a 30% reduction in power sector emissions below 2020 levels by 2030 in participating states			
	Transportation - LDV sales targets	California and the 14 other states that have adopted ZEV sales targets consistent with California's Advanced Clean Cars (ACC) II legislation are assumed to achieve their passenger car sales target of 68% electric in 2030 and 100% in 2035. Additionally, the 2 states that have only adopted legislation consistent with California's ACC I legislation are modeled to have ZEV sales reach 22% in 2025.	Tier 1 states are assumed to achieve ZEV sales shares equivalent to California's ACC II targets.	Tier 2 states are assumed to achieve sales shares equivalent to California's ACC II targets but on a delayed schedule, 3 years later than Tier 1 states.	Tier 3 states are assumed to achieve sales shares equivalent to California's ACC II targets but on a delayed schedule, 6 years later than Tier 1 states.
	Transportation - EV incentives	Major existing incentives for LDV ZEVs at the state-, utility-, and district levels from the Alternative Fuels Data Center are modeled at the state level as reductions in per-vehicle capital cost. Altogether, these are equivalent to a national average capital cost reduction for LDV EVs of \$826 per vehicle.	No additional policy action is modeled for Tier 1, Tier 2, or Tier 3 states		

Policy Type	Sector	Current Policies Scenario	Modeled scenarios		
			Tier 1 States	Tier 2 States	Tier 3 States
Non-federal	Transportation - M/HDV sales targets	California and 11 other states achieve sales targets for electric trucks by 2035 consistent with California's ACT legislation	Tier 1 states achieve ZEV sales shares equivalent to California's ACT targets.	Tier 2 states are assumed to achieve sales shares equivalent to California's ACT targets but on a delayed schedule, 3 years later than Tier 1 states	Tier 3 states are assumed to achieve sales shares equivalent to California's ACT targets but on a delayed schedule, 6 years later than Tier 1 states
	Transportation - Bus electrification	Not explicitly modeled in this scenario	All states achieve 100% electrification of new bus sales by 2030		
	Transportation - VMT reductions	Not explicitly modeled in this scenario	Tier 1 states achieve 1.25% annual VMT reductions by 2035	Tier 2 states achieve 1.00% annual VMT reductions by 2035	Tier 3 states achieve 0.75% annual VMT reductions by 2035
	Transportation - Low carbon fuel standards	Not explicitly modeled in this scenario	Tier 1 states achieve biofuels share of 20% in 2030 and 25% in 2035	No additional policy action is modeled for Tier 2 or Tier 3 states	
	Buildings - Energy efficiency	Current state-level EERS were modeled by reducing state-level building service demands	Tier 1 and Tier 2 states achieve 4% annual efficiency savings by 2030		No additional policy action is modeled for Tier 3 states
	Buildings - Zero-emission appliance standards	Not explicitly modeled in this scenario	Tier 1 states achieve 100% electric space heating and water heating sales by 2030	Tier 2 states achieve 100% electric space heating and water heating sales by 2035	No additional policy action is modeled for Tier 3 states
	Buildings - Zero-emission construction standards	Not explicitly modeled in this scenario	Tier 1 and Tier 2 states achieve 100% new electric construction by 2035		No additional policy action is modeled for Tier 3 states
	Industry - CCS targets	Not explicitly modeled in this scenario	All states with cement production install CCS capability for 40% of cement produced by 2035, consistent with California's 40% goal		
	Methane - oil and gas	Not explicitly modeled in this scenario	All states achieve 0.2% methane emissions intensity target for oil and gas production		
	Methane - waste diversion	Not explicitly modeled in this scenario	All states achieve 50% landfill methane emissions reduction target		

Policy Type	Sector	Current Policies Scenario	Modeled scenarios		
			Tier 1 States	Tier 2 States	Tier 3 States
Coal phaseout	Electricity	Not explicitly modeled in this scenario	Tier 1 states phase out unabated coal by 2030	Tier 2 and Tier 3 states phase out unabated coal by 2035	
HFCs		National HFC phasedown is implemented consistent with the American Innovation and Manufacturing (AIM) Act	Tier 1 states additionally adopt Significant New Alternatives Policy (SNAP) and Refrigerant Management Programs (RMP) programs	No additional policy action is modeled for Tier 2 or Tier 3 states	

Download the full analysis [here](#).