

ISSUE BRIEF

Analytical Response to CARB's October 29, 2025 Cap-and-Invest Workshop

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Summary

This analysis provides a technical review of California Air Resources Board (CARB)'s proposed cap-and-invest program adjustments discussed in the October 29th workshop. Using Greenline Insights' TRACE model, we evaluate two interpretations of CARB's proposed removal of 118.3 million allowances between 2027 and 2030, each tested under two emissions demand pathways. We test a third higher-ambition cap scenario with greater allowance removals, to assess the resulting allowance price pathway and economic impacts. Together, these scenarios illustrate a range of potential market outcomes under varying levels of allowance supply and demand.

Modeling results indicate that each cap trajectory results in a different market balance. A lower ambition pathway is projected to result in a substantial volume of unused allowances through 2045, resulting in undersubscribed auctions as soon as 2038 and allowance prices at the floor for the majority of the program. Both the moderate- and higher-ambition cap scenarios result in improved market balance across multiple emissions scenarios while remaining within price containment parameters.

Across all modeled scenarios, household-level effects remain modest and progressively distributed. Households earning below \$70,000 per year experience net average benefits in every case, while middle-income impacts remain cost-neutral or negligible through 2045. These results reflect differences in household energy use and spending by income level, combined with the redistributive effects of climate dividends and Greenhouse Gas Reduction Fund (GGRF) investments. Industrial assistance is also found to yield indirect household benefits, with roughly one-fifth of the associated value of free allowances passed through to in-state consumers.

About Greenline Insights

[Greenline Insights](#) is an independent, nonpartisan research firm specializing in advanced energy and economic modeling to inform effective policy design and actionable strategies. Our work spans climate and energy, industrial decarbonization, innovation, infrastructure, advanced manufacturing, and supply chain analysis – supported by custom datasets, modeling workflows, and data tools built for each project’s unique analytical needs.

California TRACE (Tool for Regional Analysis of Cap-and-Invest Economics) is a two-stage modeling framework that links allowance market dynamics and detailed economic distributional outcomes from California’s cap-and-invest program. California TRACE is built to evaluate “what-if” policy designs transparently: it projects annual allowance prices and quantities under alternative cap, offset, and reserve settings, then traces how compliance costs and allowance value flow through utilities, industries, and ultimately California households by income bracket.

California TRACE was developed by Greenline Insights, with support and partnership from Environmental Defense Fund. All methodologies, results, and commentary in this memo are the opinion of Greenline Insights and do not reflect the opinions of supporters or partners.

Overview of Modeling Scenarios

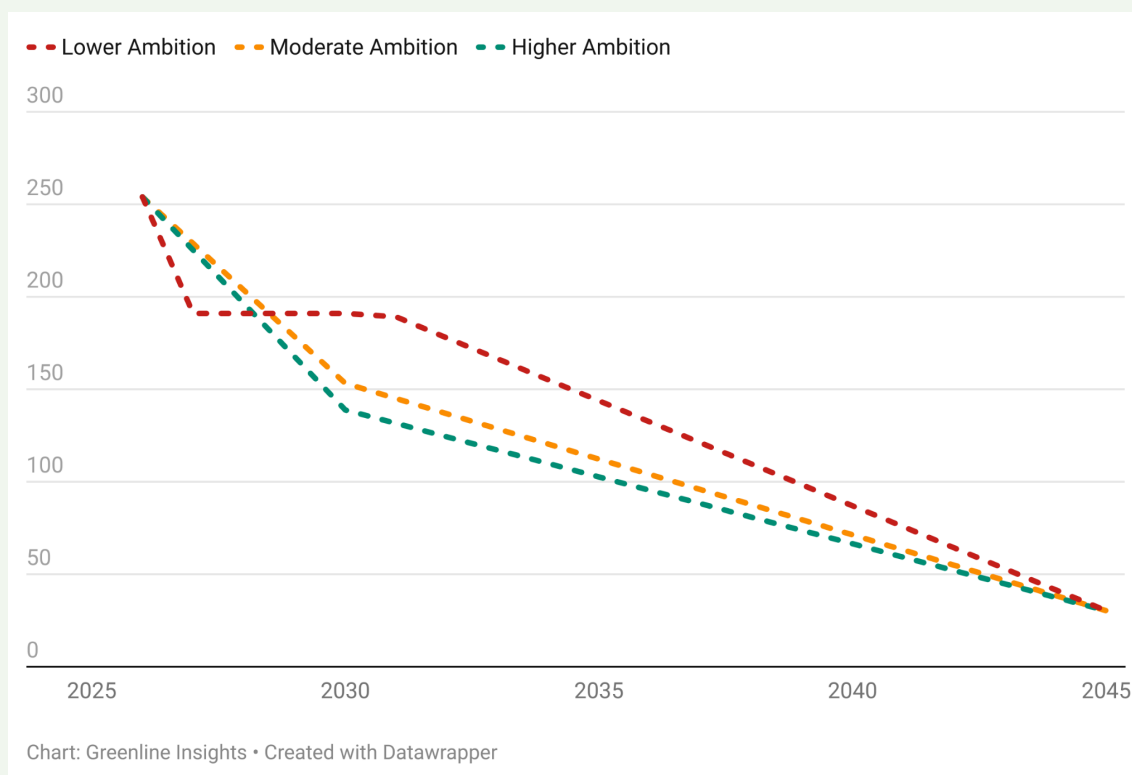
As detailed in their recent workshop, CARB proposes a removal of 118.3 million allowances from future allowance budgets. This is intended purely as a GHG accounting adjustment, to be enacted in 2027-2030 budget years. After 2030, CARB intends to maintain a “*smooth decline from 2030 budget to 2045 budget, including gradual removal of additional allowances aligned with cumulative budgets analyzed in prior workshops.*”¹

We have constructed three cap trajectories to test in the TRACE model, two of which align with CARB’s language provided in the workshop. A third scenario illustrates a cap trajectory with higher program ambition. All three scenarios differ in their cumulative allowance budgets through 2045, as well as their trajectory between 2026 and 2030.

¹ [California Air Resources Board, Cap-and-Invest Program Workshop, October 29, 2025.](#)

Table 1. Explanation of Modeled Cap Trajectories

Cap Scenario	Description
Lower Ambition Scenario	118.3 million allowances are removed from current regulatory budgets between 2027 and 2030 (creating a “plateau” shape). Between 2031 and 2045, the cap declines linearly from the 2030 budget under current regulations (200.5 MMTCO ₂ e) to an 85% reduction budget in 2045 (30.3 MMTCO ₂ e).
Moderate Ambition Scenario	Between 2027 and 2030, allowance budgets decrease linearly each year relative to current regulation (-11.8 MMTCO ₂ e in 2027, up to -47.3 MMTCO ₂ e in 2030). This results in an allowance budget of 153.2 MMTCO ₂ e in 2030, with 118.3 million in cumulative removals through 2030. Between 2031 and 2045, the cap declines linearly from the 2030 allowance budget to 30.3 MMTCO ₂ e.
Higher Ambition Scenario	This alternative cap scenario removes 154.3 million allowances between 2027 and 2030, decreasing linearly to an allowance budget of 138.8 MMTCO ₂ e in 2030. This 2030 budget aligns with Proposed Scenario A from the SRIA. Between 2031 and 2045, the cap declines linearly from this 2030 allowance budget to 30.3 MMTCO ₂ e in 2045.

Figure 1. Modeled Cap Trajectories, MMTCO₂e


The Lower and Moderate Ambition scenarios remove the same quantity of allowances from the 2027-2030 period, offering different interpretations of the 118.3 million allowances of removal suggested by CARB. The Higher Ambition Scenario offers an alternative with accelerated removals in the short term, resulting in a lower cumulative supply through 2045.

Table 1. Cumulative Allowance Budgets Under Cap Scenarios

Cap Trajectory	Cumulative Allowance Budget, 2026 - 2045 ²
Lower Ambition Scenario	2,664 MMTCO ₂ e
Moderate Ambition Scenario	2,333 MMTCO ₂ e
Higher Ambition Scenario	2,196 MMTCO ₂ e

All three cap scenarios were simulated in the TRACE model, which forecasts allowance market behavior and resulting net economic impacts by household income and industry. We developed forecasts for allowance price pathways by simulating how each of the three cap trajectories interacts with two emissions demand scenarios, which are described below:

- A. Scoping Plan Emissions** - This trajectory mirrors the projected cap-and-invest covered emissions described as “Proposed Scenarios” in CARB’s Standardized Regulatory Impact Assessment (SRIA) released in 2024. This scenario serves as an approximate representation of the expected emissions outcome for California with full and successful implementation of the 2022 Scoping Plan.
- B. Midpoint Emissions** - This emissions scenario represents continued policy ambition in California, with certain key missing policy parameters that differentiate from the Scoping Plan Emissions scenario (such as a potential loss of waivers, or a moderately ambitious cap-and-invest program). As a result, the state achieves emissions reductions that are halfway between Scoping Plan Emissions and the “Baseline” established in the 2024 SRIA.

The relative probability of any emissions scenario occurring is outside the scope of this model. However, the likelihood of a Scoping Plan Emissions scenario increases with greater ambition from the cap-and-invest program.

² These figures are considered initial values in the model. Final model results account for changes in supply due to APCR triggers, private bank use, and future budget adjustments due to offsets.

Lower Ambition Scenario

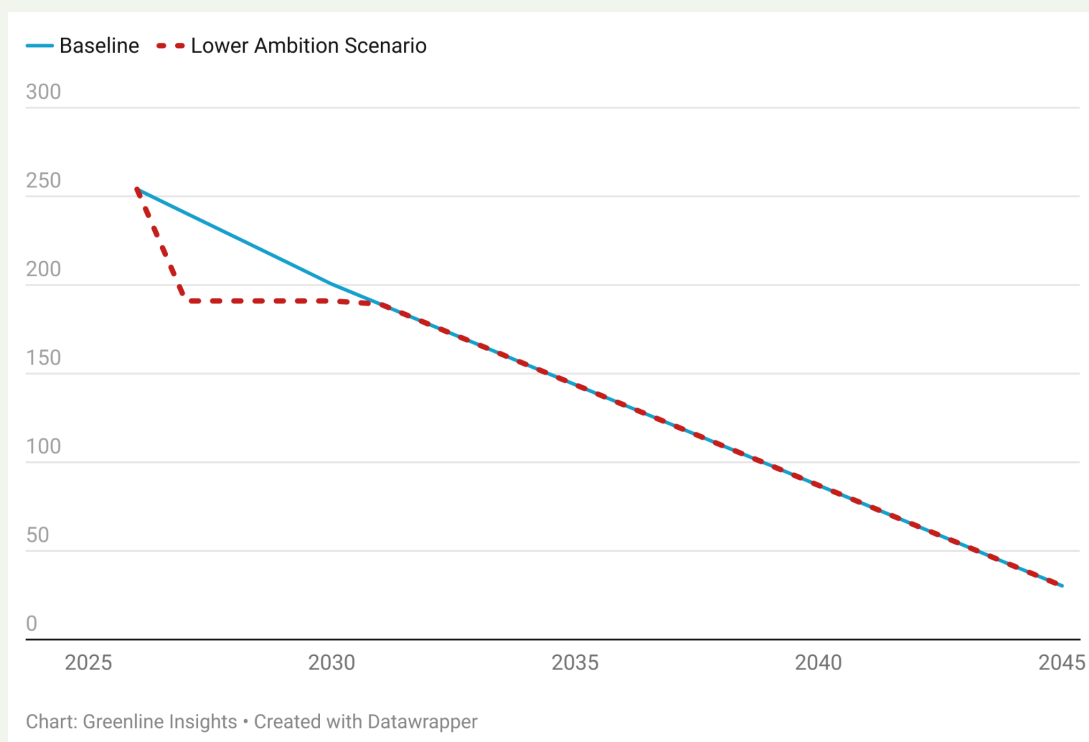
In the Lower Ambition Scenario, 118.3 million allowances are removed between 2027 and 2030, in a schedule resembling a plateau, after which the cap declines linearly from 189.2 million allowances in 2031 to 30.3 million allowances in 2045.

Between 2026 and 2045, this scenario contains a cumulative allowance supply of 2,664 MMTCO₂e. Compared to formerly proposed cap trajectories in the SRIA, this is:

- **+161 MMTCO₂e** higher than cumulative supply of the “Simple Target” scenario.
- Approximately **+320 MMTCO₂e** higher than the cumulative supply of SRIA Proposed Scenarios (Proposed Scenario A, Smoothed Option 1, Smoothed Option 2).

A comparative Baseline cap trajectory is visualized below, representing current regulations and a cap trajectory aligned with 85% below 1990 levels by 2045 in the post-2030 era:³

Figure 2. Cap Trajectory Under a Lower-Ambition Scenario, MMTCO₂e



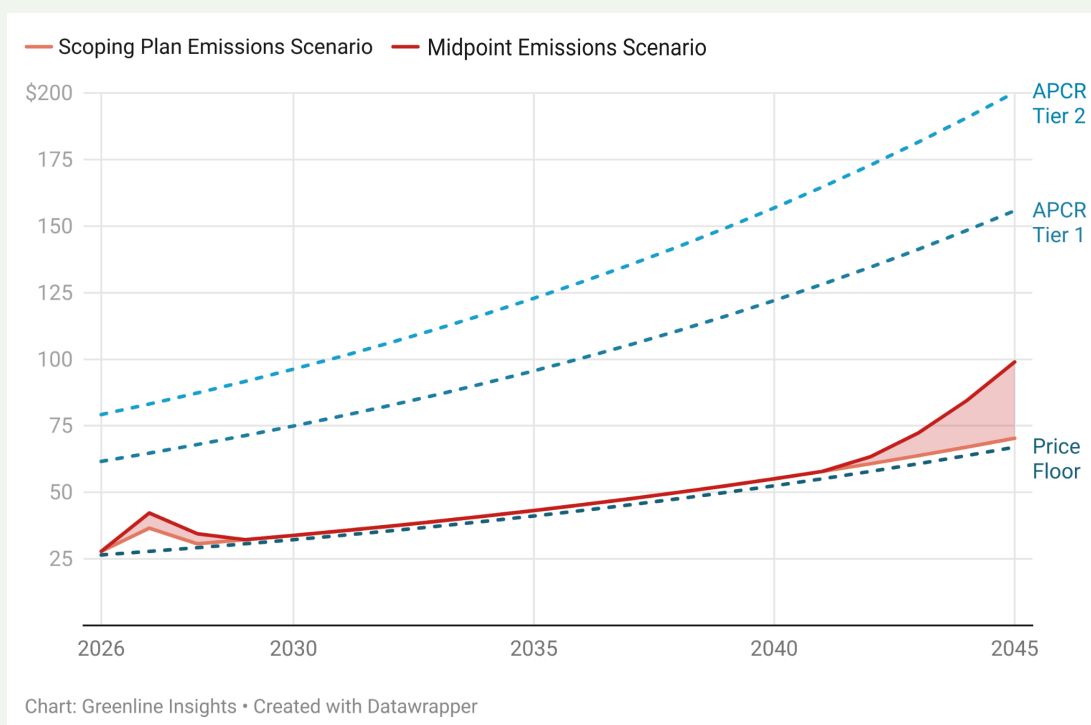
³ CARB has not presented the “Baseline” scenario as a potential cap trajectory. It is presented here purely to illustrate the schedule of allowance removals under the Lower Ambition Scenario..

TRACE modeling suggests that this cap trajectory results in a large pool of excess allowances remaining in 2045. A Midpoint Emissions Scenario, which represents moderately successful policy conditions but not full Scoping Plan alignment, results in **over 150 million allowances in excess of demand by 2045**.

A Scoping Plan-aligned emissions scenario (as projected in the SRIA) would result in **over 500 million allowances in excess of demand by 2045**. Absent further cap adjustments, state auctions could become undersubscribed as soon as 2038, as the accumulated private allowance bank would sufficiently cover all remaining compliance obligations.

In both emissions scenarios, allowance prices under the Lower Ambition Scenario remain on the floor for the majority of the program. Note that the TRACE model simulates allowance markets on a year-by-year basis, resulting in allowance prices that may, in reality, be smoothed out by forward-looking speculative behavior.⁴

Figure 3. Allowance Price Pathways Under a Lower Ambition Scenario, \$/MTCO₂e

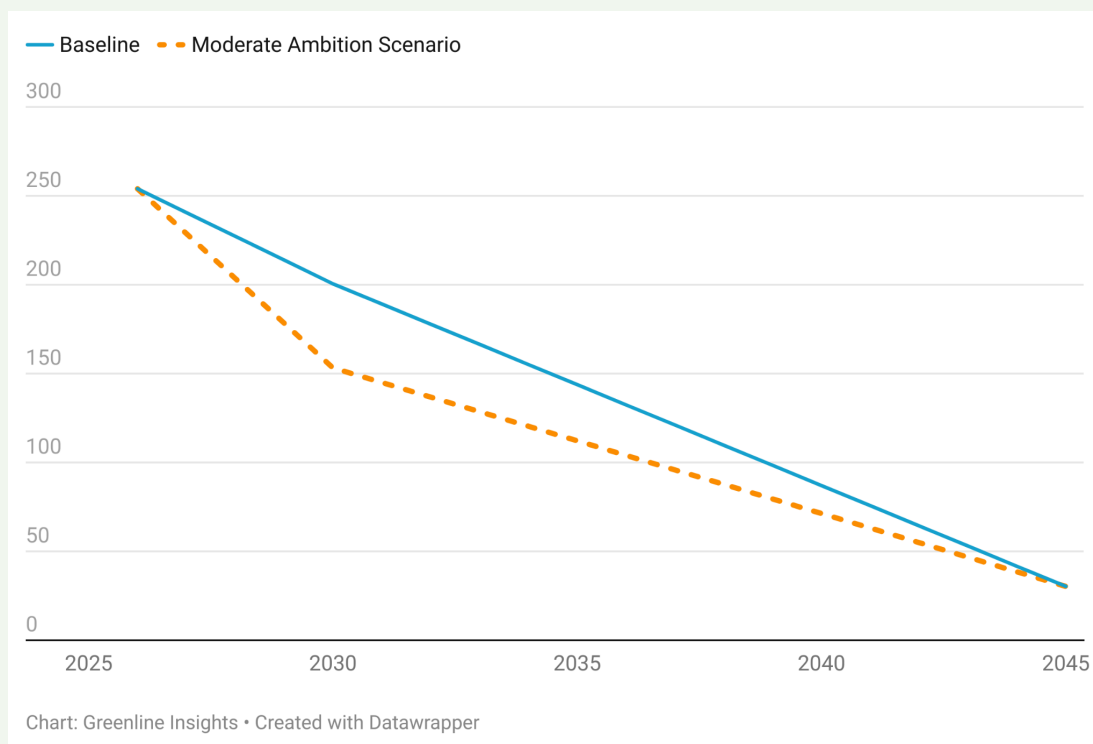


⁴ Price trajectory outputs from the TRACE model are also available in smoother, post-processed forms such as a Hotelling path and logarithmic best-fit lines. Each of these approaches represent different economic theories on real-world market speculation and behavior. For transparency, this memo presents TRACE model outputs in their raw form to detect price floor settlement and acute APCR trigger events.

Moderate Ambition Scenario

Like the Lower-Ambition Scenario, the Moderate Ambition Scenario removes 118.3 million allowances from cumulative allowance supply between 2027 and 2030. However, this scenario then holds the annual budget at a new low of 153.2 MMTCO₂e in 2030, and declines linearly to 30.3 allowances in 2045. This budget possesses a similar 2026-2045 cumulative supply to Proposed Scenario A, Smoothed Option 1, and Smoothed Option 2 established by CARB in the 2024 SRIA and following workshops.⁵

Figure 4. Cap Trajectory Under a Moderate Ambition Scenario, MMTCO₂e



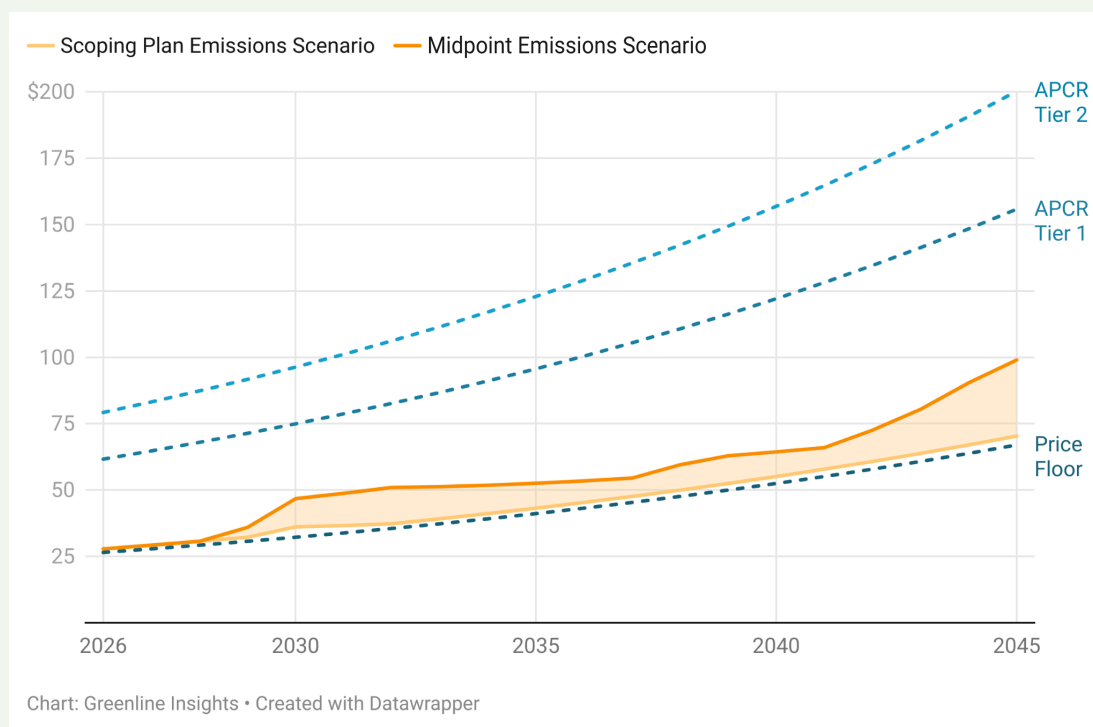
Modeling results find that this cap trajectory results in different allowance price pathways under different emissions scenarios. Under a Scoping Plan Emissions scenario, approximately **200 million excess allowances** remain in the system through 2045, which leads to market undersubscription as soon as 2041. As a result, allowance prices remain at or near the floor for the majority of the program.

⁵ Note that SRIA-derived cap trajectories have been slightly modified in this analysis, to reflect recent CARB indications that no cap adjustments will take place in 2026.

Under the Midpoint Emissions Scenario, which assumes California is unable to meet its full policy ambition outlined in the 2022 Scoping Plan, the Moderate Ambition Scenario remains within the program's ascribed floors and ceilings. Said differently, the Moderate Ambition Scenario can withstand a more pessimistic emissions trajectory than under the Scoping Plan Emissions Scenario.

In addition, the Moderate-Ambition Scenario provides a stronger price pathway compared to the Lower-Ambition Scenario, which may support stronger GGRF program revenues and avoid undersubscribed auctions. Results provided in Figure 5 below present a range of potential price outcomes under varying emissions scenarios.

Figure 5. Allowance Price Projections Under a Moderate Ambition Scenario, \$/MTCO₂e



As noted in prior sections, price outputs from the TRACE model are provided in raw form, rather than post-processed into a Hotelling path or logarithmic best fit. Forward-looking speculation may cause real-world price paths to differ from TRACE outputs. Rather than an exact price prediction, TRACE model outputs are best used as a directional stress test to assess long-term market balance and the risk of APCR trigger events.

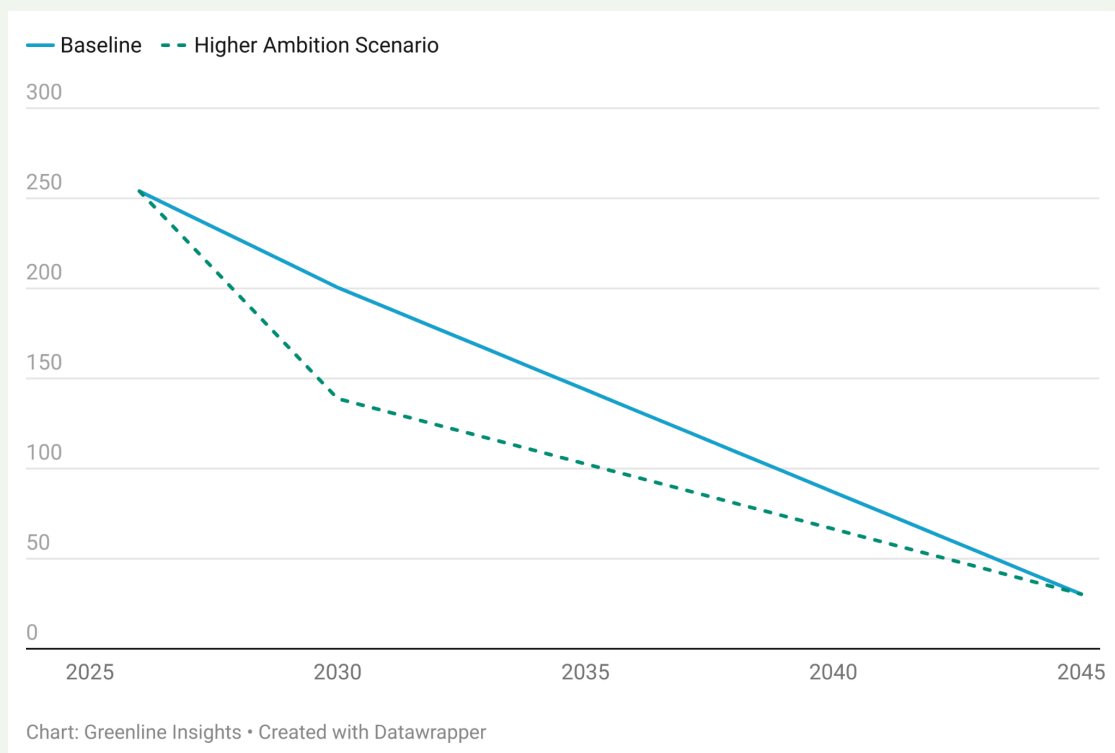
Higher Ambition Scenario

The Higher Ambition Scenario distinguishes itself from the other scenarios by providing greater removals from the cap trajectory than as suggested in CARB's October 29th workshop. This scenario was designed to achieve the following characteristics:

- Linear, incremental reductions in annual budget with no plateaus or increases
- Greater than 118.3 million allowances removed between 2027 and 2030
- A lower cumulative allowance supply than the Lower and Moderate Ambition Scenarios
- Sufficient allowance supply to maintain program stability and feasibility⁶

The resulting cap trajectory illustrated below removes 154.3 million allowances between 2027 and 2030, resulting in a 2030 annual budget of 138.8 MMTCO₂e, after which the cap declines linearly to 30.3 MMTCO₂e in 2045.

Figure 6. Cap Trajectory Under a Higher-Ambition Scenario

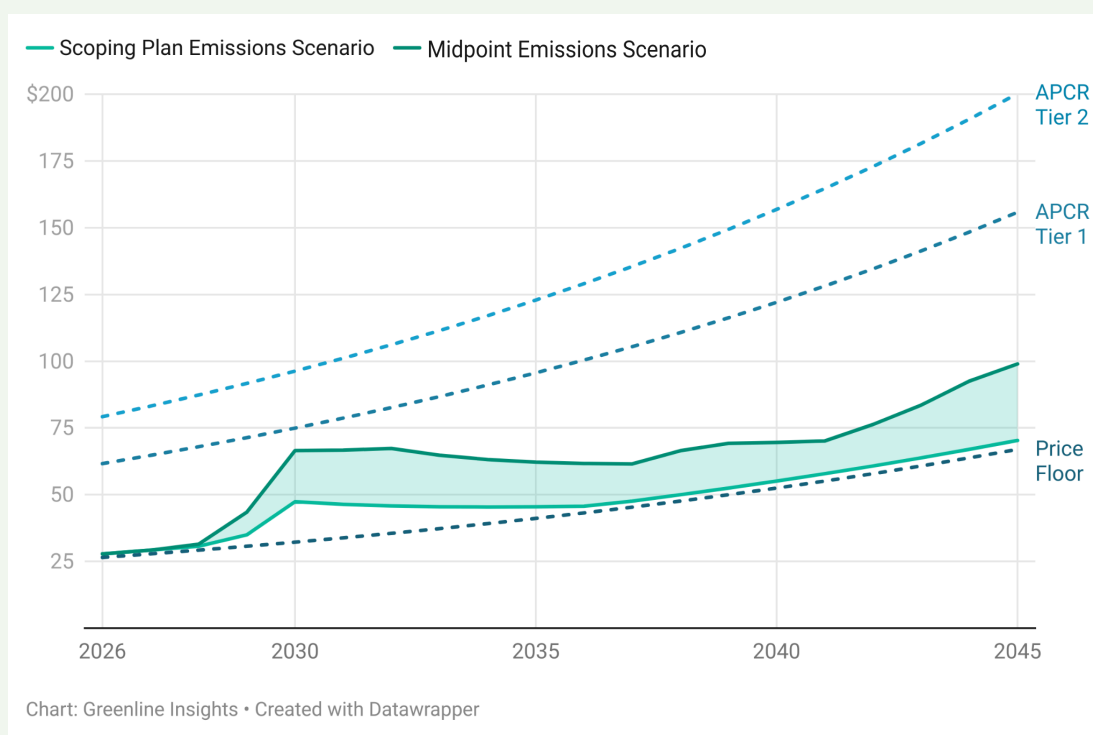


⁶ While TRACE allows for rapid turnaround of new scenarios, it is not an optimization platform. The Higher Ambition Scenario does not present the only cap trajectory that satisfies these parameters, nor do we attempt to claim it is the single most optimal trajectory compared to all possible cap trajectories.

TRACE produces a larger spread of allowance price outcomes under this scenario, depending on emissions, that still remain within the APCR trigger boundaries. An optimistic Scoping Plan Emissions pathway results in 60 MMTCO₂e in excess allowances remaining in 2045, resulting in a price pathway that lifts off the floor through 2035, before returning to the floor in the final ten years. The risk of auction undersubscription does not occur until the final 2 years of the program, where remaining private bank reserves may be sufficient to cover remaining compliance obligations.

A more pessimistic scenario with a Midpoint Emissions pathway results in greater price action, with the program staying above the floor from 2027 onwards, but remaining underneath APCR trigger prices for the duration of the program.

Figure 7. Allowance Price Projections Under a Higher Ambition Scenario, \$/MTCO₂e



Across all scenarios, greater program ambition (expressed as an accelerated decline in the cap trajectory) leads to a wider range of potential prices. Under a Scoping Plan Emissions Scenario, all three cap trajectories lead to allowances prices near the floor for the majority of the program, with potential auction undersubscription in later years. Under a Midpoint Emissions Scenario, all cap trajectories remain within market bounds and avoid APCR triggers.

Net Household Impacts by Scenario

Household-level outcomes were assessed in the TRACE model to understand how different cap and emissions pathways affect Californians across income groups. Under all modeled scenarios, household impacts remain modest and progressively distributed, with lower-income households (\$70k or less in annual income) consistently experiencing net benefits on average.

Table 2. Net Household Impacts by Scenario

Cap Scenario	Emissions Scenario	Household Impacts
Lower Ambition	Scoping Plan Emissions	Households earning \$200k or less see an average annual benefit of \$12, with the lowest-income households realizing benefits of up to \$95 per year.
Lower Ambition	Midpoint Emissions	In the short-term (2026-2030), impacts are neutral for households earning \$150k or less. Through 2045, households earning \$100k or less see an average annual benefit of \$13.
Moderate Ambition	Scoping Plan Emissions	Short-term effects are neutral for households earning \$200k or less. Through 2045, households earning \$100k or less see a modest benefit of \$14 per year.
Moderate Ambition	Midpoint Emissions	Short-term effects are neutral for households earning \$150k or less per year. Through 2045, households earning \$70k or less remain net-positive, with up to \$60 in annual benefits for the lowest-income households.
Higher Ambition	Scoping Plan Emissions	Short-term effects are neutral for households earning \$150k or less per year. Through 2045, effects remain slightly positive for households earning \$100k or less.
Higher Ambition	Midpoint Emissions	Short-term effects are net-positive for households earning \$100k or less. Through 2045, households earning \$70k or less remain nearly net-neutral, with up to \$55 in yearly benefits for the lowest income households.

Across all cap and emissions scenarios, the distributional effects are progressive. Lower-income households experience greater proportional benefits due to differences in spending and energy consumption patterns, relative to higher income households. These estimates incorporate the direct and indirect effects of the program, including from energy cost increases, business cost pass-through, climate dividends, benefits pass-through from industrial and small business assistance, and cash rebates from GGRF programs directed at households.

Household benefits may be higher in reality. The TRACE model does not incorporate additional household gains from long-term energy savings associated with GGRF-funded efficiency and electrification investments, nor the indirect cost savings that may arise from business-targeted GGRF programs that reduce operating costs. Additionally, the TRACE model does not consider behavior change due to price elasticity (such as reduced household energy consumption due to price increases) as a household benefit.

Household Impacts - Commercial and Industrial Pass-Through

While industrial allocations are not explicitly intended as household protections, the TRACE model finds that 20% of industrial assistance (in the form of free allocation) is passed through to in-state households. This translates to hundreds of millions of dollars per year in household benefits, which are incorporated into the household impact figures described above.⁷

Of all EITE industries, food-related manufacturing (such as dairy and meat processing, snack manufacturing, and breweries) sells the greatest percentage of their products to in-state consumers, leading to the greatest pass-through rates to California households. Petroleum refineries and paper mills also exhibit modestly above-average pass-through rates, relative to other EITE industries.

CARB presents multiple approaches to industrial allowance allocation in the October 29th workshop, labeled Concept 1 and Concept 2. These two approaches create negligible differences in net household impacts, as the majority of household impacts are driven by direct costs and direct benefits from climate dividends.

⁷ The TRACE model assumes 100% pass-through of all industries to their end-use customers. As a result, the 20% pass-through rate for EITE industries represents the portion of sales within these industries that is attributable to in-state households.

Key Assumptions

We assume that 2% of future allowance budgets are set aside for APCR reserves. On slide 19 of the workshop materials, CARB states:

“No removal of allowances in the Allowance Price Containment Reserve (APCR) or Price Ceiling accounts; deposit a small amount of post-2030 annual budgets into APCR Tier 1 to bolster cost-containment.”

This statement implies that no additional allowances will be moved to the APCR before 2030, other than what is already deposited from the 2021 to 2030 budgets (with a total current size of 156 million allowances). However, on slide 44, CARB suggests that a continuous 2% of allowances will be set aside for APCR reserves, including in pre-2030 years.

The TRACE model computes slightly different allowance distributions than what is suggested on Slides 44 and 45 of the October 29th workshop, as CARB’s estimates do not include allowance removals in response to offset use in the prior year. The TRACE model assumes that, beginning in 2027, an amount of allowances is removed from state-owned auctions equal to the amount of offsets used in the prior year. These allowances are solely removed from state-owned allowances designated for auction. Future offset use is assumed to remain at 90% of annual statutory limits, resembling historical behavior. These removals occur consistently each year, regardless of timing with compliance periods.

In the TRACE model, we assume that 2% of future cap budgets are added to the APCR, beginning in 2027. For this model run, the TRACE model was calibrated to industrial allocation Concept 2 for both price and household impact projections. Concept 1 results in negligible differences in model outputs.

For the purpose of household impacts, allowance budget distributions follow reasonable best-fit assumptions based on the current regulation and expected changes. This includes a phase-out of natural gas consignment in favor of electric utility consignment by 2030, after which total consignment allocations decrease proportionately along with the overall cap trajectory. Climate dividends are distributed evenly per household. State-owned allowances for auction (and subsequent GGRF revenue) are calculated as the remainder of annual budgets, after consignment, free allocation, and APCR reserves have been dedicated on a yearly basis.

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