

State of California  
Air Resources Board

# **Regulation for the California Cap on Greenhouse Gas Emissions and Market- Based Compliance Mechanisms 2024 Amendments**

*Standardized Regulatory Impact Assessment  
(SRIA)*

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**California Air Resources Board  
1001 I Street  
Sacramento, California 95814**

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## I. Introduction

This Standardized Regulatory Impact Assessment (SRIA) assesses the economic impacts of California Air Resources Board (CARB or Board) staff's proposal to update the Regulation for the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms (Cap-and-Trade Regulation or Regulation). The Cap-and-Trade Program (Program) is one of the key policies implemented by CARB to reduce greenhouse gas (GHG) emissions to help the state achieve its climate targets.

California has been on a path to reducing its greenhouse gas (GHGs) since California's Global Warming Solutions Act of 2006, also known as Assembly Bill (AB) 32 (Nunez, Chapter 32, Statutes of 2006), was signed into law. Most recently, the 2022 Scoping Plan for Achieving Carbon Neutrality (2022 Scoping Plan Update; CARB 2022a)<sup>1</sup> laid out a cost-effective and technologically feasible path to achieve the mandates in AB 1279 (Muratsuchi, Chapter 337, Statutes of 2022), which requires both reducing anthropogenic emissions by 85% below 1990 levels by 2045 and achieving carbon neutrality by 2045. Successful implementation of the 2022 Scoping Plan Update requires reductions in GHG emissions at sources covered by the Regulation and deployment of both carbon capture and sequestration and direct air capture.

CARB initially approved the Regulation in 2011 as the market mechanism allowed under AB 32 to reduce GHG emissions. The Cap-and-Trade Program establishes a declining cap on approximately 80% of total statewide GHG emissions and creates a strong economic incentive for investments in cleaner, more efficient technologies. As such, the Cap-and-Trade Program does not cover all emissions included in the state numerical targets, and there remain emissions sources that must be addressed through other policies such as natural and working lands and short-lived climate pollutants. If other policies are not in place to reduce emissions in those non-covered sectors, there is a risk of not achieving the state's climate targets. Importantly, the broad sectors included in the Program to date ensure a level playing field by assessing a carbon price on key sectors that contribute to both greenhouse gases and harmful local air pollution. Likewise, the Cap-and-Trade Program is not the only policy for reducing emissions covered by the Program. CARB has a suite of other regulations, such as the Low Carbon Fuel Standard (LCFS), the first and second phase of Advanced Clean Cars (ACC and ACCII), Advanced Clean Trucks, Advanced Clean Fleets, and several others that reduce emissions from those sectors covered by the Program.

In the Program, CARB issues allowances equal to a declining annual budget (i.e., the "cap") that is set according to California's GHG reduction goals. One allowance equals one metric ton of carbon dioxide equivalent (MTCO<sub>2e</sub>) using the 100-year global warming potential. Each compliance period represents either a 2-year or 3-year block in the Program. Having multiyear compliance periods allows for smoothing of annual emissions variations that may result from drought or unique production conditions. A steady decline in allowance supply over time ensures a long-term steadily increasing carbon price signal to prompt emissions reductions to

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<sup>1</sup> For more information, see [2022 Scoping Plan Documents | California Air Resources Board](#)



achieve the statewide target. Long-range budgets allow for long-term business planning for investment in low carbon energy and technology.

The Program is designed to achieve the most cost-effective statewide GHG emissions reductions. There are no individual or facility-specific emissions reduction requirements, which would otherwise increase the cost of achieving statewide targets. Rather, each covered entity must report and verify its GHG emissions annually and acquire and surrender compliance instruments in an amount equal to its total covered GHG emissions during each compliance period. Covered entities can also meet a small portion of their compliance obligation by surrendering offset credits, which are compliance instruments that are derived from rigorously verified emissions reductions from projects outside the scope of the Program. By virtue of the current linkage with the Cap-and-Trade System in Québec, California entities can use Québec-issued allowances and offset credits, as all compliance instruments issued by linked jurisdictions are fully fungible. California, Quebec, and Washington state recently released a statement to jointly explore linkage of the California and Quebec linked program with the Washington cap-and-invest program. Such a linkage would need to be part of a future rulemaking after the prerequisite evaluations required under Senate Bill 1018 had been completed.

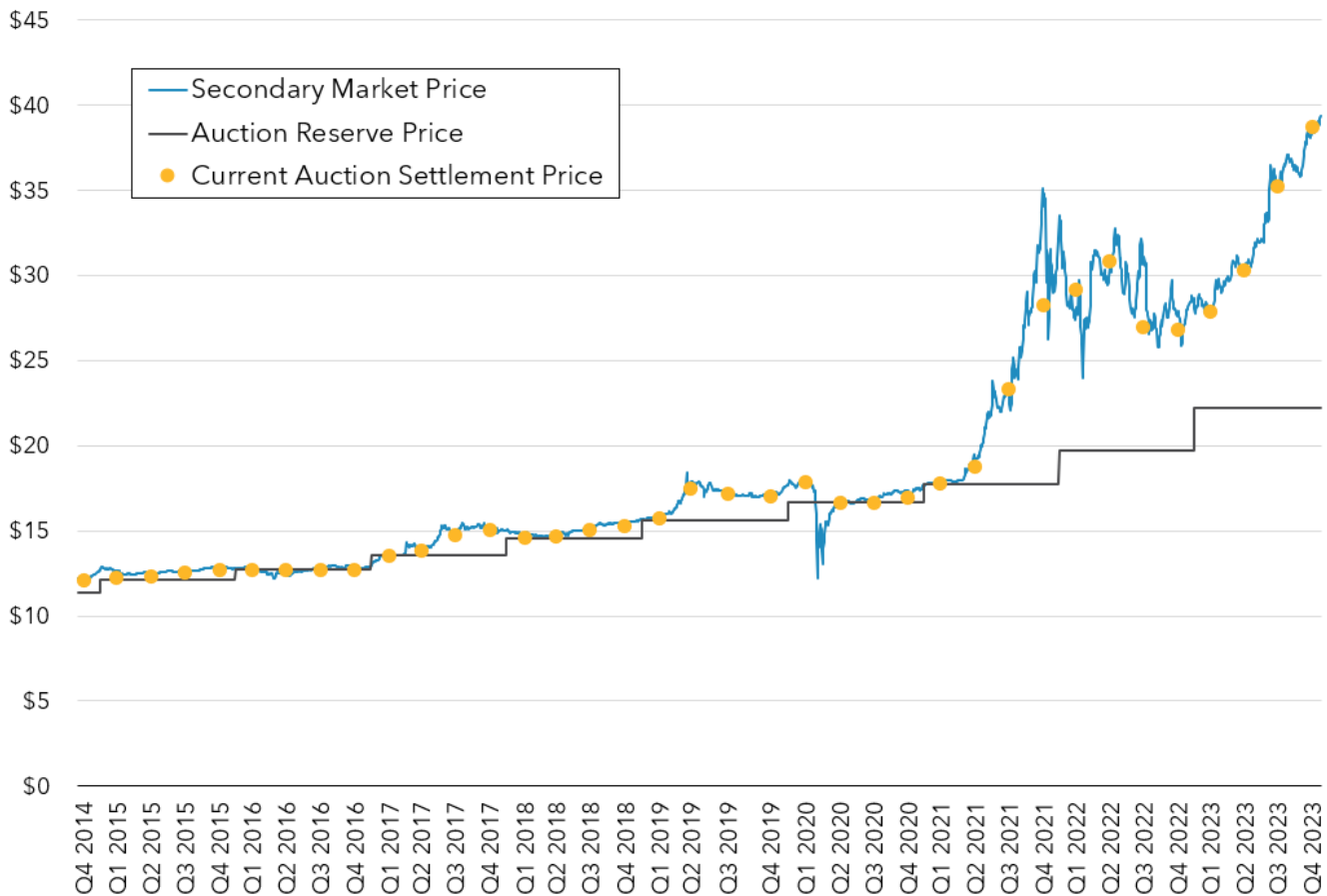
The Program gives covered entities the flexibility to develop their most cost-effective compliance strategy. Covered entities may find methods to reduce emissions at their own facilities, trade allowances and offset credits with other firms, and/or purchase allowances at auction. Through these mechanisms, the Program is designed to leverage the power of the market to find the most cost-effective methods to reach California's environmental goals. The ability to auction and trade allowances establishes a price signal needed to drive long-term investment in cleaner fuels, new technology, and more efficient use of energy. The allowance price represents the market's estimation of the cost to abate carbon emissions to achieve the goal and incorporates factors such as technology cost and readiness and hurdles such as permitting.

Throughout the more than 12 years since the Board's original adoption, the basic framework of the Program has worked well and continues to support a stable and steadily increasing price signal. The Program has worked in concert with other policies and regulations to help the state achieve its 2020 GHG target several years ahead of the statutory mandate and to continue to support declining emissions ever since. Figure 1 provides the allowance price history of the Program demonstrating the steadily increasing carbon cost (CARB 2023a).<sup>2</sup>

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<sup>2</sup> Historic allowance prices and other Program data can be found at the Cap-and-Trade Program [Data Dashboard](#).

Figure 1: Cap-and-Trade Program Allowance Prices Through 2023



Through 2023, revenues raised from the quarterly auctions have also resulted in nearly \$27 billion to the Greenhouse Gas Reduction Fund (GGRF). Over 70% of funding implemented has benefited priority populations. Over the project lifetimes, the projects funded by the GGRF are estimated to reduce 98 million MTCO<sub>2e</sub> and 85 thousand short tons of criteria air pollutants (CARB 2023b, CARB 2023c).

The three-pronged approach of incentives, regulations, and carbon pricing in the form of a Cap-and-Trade Program has been included in every AB 32 Scoping Plan since the first one was adopted in 2008 (CARB 2008). More recently, the 2022 Scoping Plan Update, approved by CARB in December 2022, states the need to continue with a diverse portfolio of policies including the ongoing implementation of the Cap-and-Trade Program.

The Regulation has been amended eight times since its inception to reflect the increased climate ambition laid out in statutes, lessons learned through implementation, linkages with other similar programs, and other direction from the Legislature. Staff are proposing several changes to the Regulation in response to the 2022 Scoping Plan Update, the signing of AB 1279, and the existing 2030 GHG reduction requirements enacted through Senate Bill (SB) 32 (Pavley, Chapter 249, Statutes of 2016). Recent updates to the AB 32 GHG Emission Inventory also merit a review of the allowance budgets in the context of the target to reduce

GHG emissions to 40% below 1990 levels by 2030 as called for in SB 32 (CARB 2023d)<sup>3</sup>. The 2022 Scoping Plan Update also identifies a need to increase ambition from 40% to a 48% reduction in GHG emissions below 1990 levels by 2030 to be on track to 2045 targets. Both of these factors suggest adjusting the 2025-2030 annual allowance budgets in Table 6-2 of the Regulation to remove potential allowances from the market. The proposed allowance removals total 264 million allowances from 2025-2030. Other proposed changes include those listed in Section B, Description and Statement of Need for the Proposed Amendments. Staff began conceptually discussing many of these items during an informal public process initiated in November 2022, and has hosted a total of four public workshops and two community meetings. The proposed changes would increase the Program price signal and increase the incentive for covered entities to invest in GHG reduction activities sooner.

While this is not a formal 45-day staff proposal, the analysis in this SRIA provides an economic assessment of preliminary proposed amendments (Proposed Amendments) to the Cap-and-Trade Regulation. These Proposed Amendments reflect several potential changes, including updates to improve the Program's overall effectiveness and proposals for increasing ambition through the removal of allowances in this decade. Since AB 398 (Garcia, Chapter 135, Statutes of 2017) sets forth the design of the Program through 2030, none of the proposals include any changes to the elements prescribed by AB 398. Post 2030 considerations are also included as they could have a bearing on a final proposal for amendments that would take effect through 2030. The SRIA provides an economic assessment using the best information available, is particularly useful to compare the alternatives presented, and may not reflect the precise real-world potential impact of the Proposed Amendments as there are no models or tools to comprehensively capture all real-world details. A formal rulemaking package will follow this SRIA after additional public process and will include an Initial Statement of Reasons that goes into the rationale for each proposed amendment and may reflect any changes proposed after the completion of this SRIA.

Table 1 provides an overview of the costs, benefits, and cost effectiveness of the Proposed Amendments. The Proposed and alternative scenarios remove a different number of Program allowances corresponding with different 2030 GHG targets (see further discussion in Chapter VI, Alternatives). Figures for the Proposed Amendments are presented as a range, which is needed to reflect the uncertainties in costs, emissions, and benefits that depend on whether 2025-2030 Program allowances are removed from the general allowance budgets for auctions and allowance allocation, from the Allowance Price Containment Reserve, or from some combination thereof. As described in CARB's public workshop presentation on October 5, 2023 (CARB 2023e), the costs and benefits of the Proposed Scenario are bounded by different options for where allowances are removed from. "Proposed Scenario A," would remove all allowances from the general allowance budgets for auction and allocation, and "Proposed Scenario C," would remove all possible allowances from the Allowance Price Containment Reserve, with the remainder removed from the general budgets for auction and allocation. A midpoint scenario, "Proposed Scenario B," would remove half of the allowances from general budgets for auction and allocation and the other half from the Allowance Price Containment Reserve. Together, these three scenarios are referred to as the "Proposed Scenarios" in this

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<sup>3</sup> See [Frequently Asked Questions: Greenhouse Gas Emissions Inventory](#) for more information.

analysis. Results of staff’s assessment of the Proposed Scenarios are thus expressed as a range.

Table 1: Summary of Cumulative Statewide Impacts of the Proposed Amendments Occurring from 2025 to 2046<sup>4</sup>

<b>Category of Cost or Benefit</b>	<b>Proposed Scenarios (48% GHG Reduction by 2030)</b>
Net Direct Costs (Compliance + Abatement) (\$ billion)	\$79.4 – \$82.8
Revenues (GGRF + Ratepayer) (\$ billion)	\$24.7 – \$28.1
NOx Reduction (thousand short tons)	312.0 - 312.1
PM <sub>2.5</sub> Reduction (thousand short tons)	51.5 - 51.8
GHG Reduction (million MTCO <sub>2e</sub> )	978.3 - 983.3
Avoided Cardiopulmonary Mortalities <sup>5</sup>	4,960 (2,740 – 7,080)
Monetized Health Benefits (\$ billion)	\$73.0
Social Cost of Carbon Benefit <sup>6</sup> (\$ billion)	\$28 - \$460

At a July 27, 2023, workshop, CARB staff presented preliminary concepts and an initial framework for updating the Cap-and-Trade Program allowance budgets, and stakeholders had an opportunity to provide verbal and written comments and to propose alternatives for consideration (CARB 2023d). Staff will present a formal package of Proposed Amendments for Board consideration in 2024. Continued interactions and input from stakeholders, the Environmental Justice Advisory Committee (EJAC), the Independent Emissions Market Advisory Committee (IEMAC), external researchers, and other regulatory agencies will inform the proposal.

## A. Regulatory History

Climate change is one of the most serious environmental threats facing humankind, and California is already feeling its effects. California committed to take action to address the threat through the adoption of AB 32, which is codified at California Health and Safety Code sections 38500 *et seq.* AB 32 requires California to reduce its statewide GHG emissions to 1990 levels by 2020, to maintain and continue GHG emissions reductions beyond 2020, to develop a comprehensive strategy to reduce dependence on fossil fuels, to stimulate investment in clean and efficient technologies, and to improve air quality and public health. It identifies CARB as

<sup>4</sup> All figures are cumulative values during 2025-2046, expressed relative to the Baseline Scenario. Monetary values are expressed in 2023 U.S. dollars, except for monetized health benefits and social cost of carbon, which are expressed in 2022 U.S. dollars. Since annual California CPI for 2023 was unavailable at the time of drafting the SRIA, 2022 U.S. dollars could not be precisely converted to 2023 U.S. dollars and are treated as equivalent for purposes of comparison of costs and benefits.

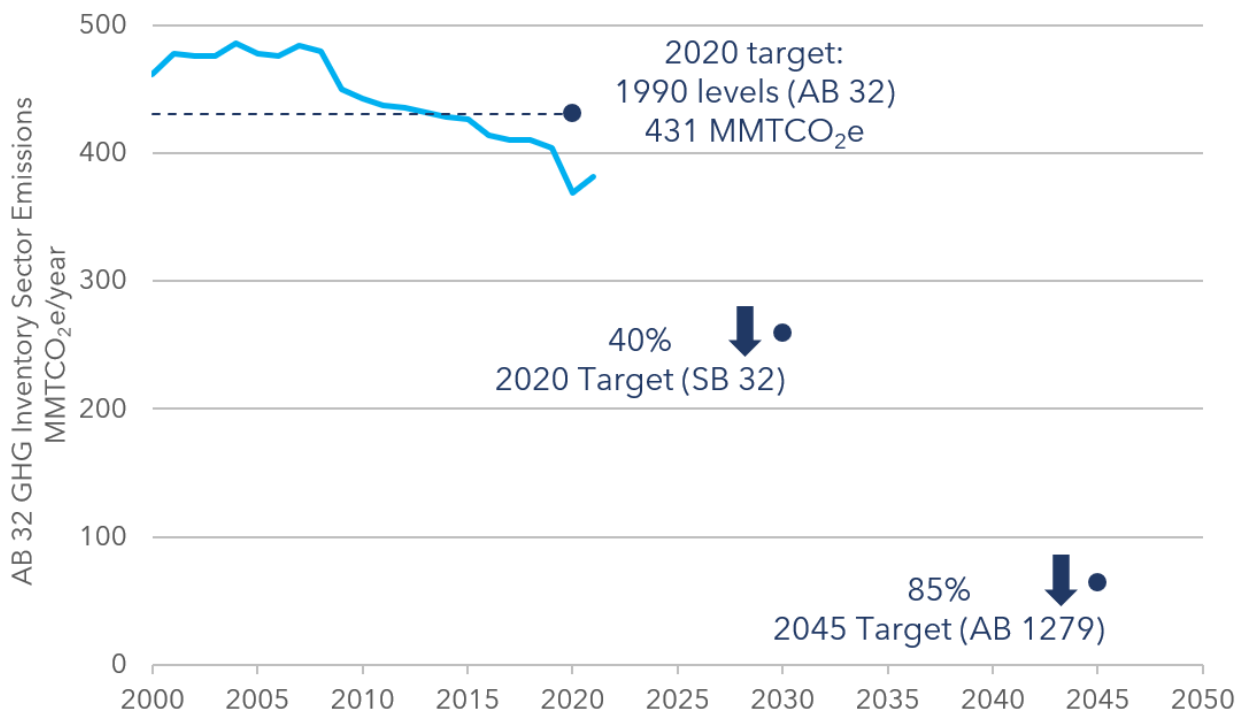
<sup>5</sup> Range included for avoided cardiopulmonary mortalities represents a 95% confidence interval.

<sup>6</sup> Range included for Social Cost of Carbon Benefit represents the application of different discount rates. See further discussion in Section II.I. Social Cost of Carbon.

the State agency charged with monitoring and regulating sources of the GHG emissions that cause climate change. AB 32 also requires CARB to work with other jurisdictions to identify and facilitate the development of integrated and cost-effective regional, national, and international GHG reduction programs.

Furthermore, AB 32 authorizes CARB to use a market-based mechanism to reduce GHG emissions, and CARB promulgated the Cap-and-Trade Regulation pursuant to this authority. The Legislature reaffirmed California’s commitment to acting against climate change by adopting SB 32, which further directs CARB to ensure that state GHG emissions are reduced to at least 40% below the 1990 level no later than December 31, 2030. In addition, AB 398 amended certain provisions of AB 32 to take effect starting January 1, 2021, and clarifies the role of the Cap-and-Trade Program in achieving the 2030 GHG reduction target. In passing AB 398, the Legislature, through a two-thirds supermajority vote, directed many of the design elements in the existing Regulation, while simultaneously offering strong support for the Cap-and-Trade Program as one of California’s key tools for achieving the State’s emissions reduction targets. More recently, AB 1279 calls for achieving carbon neutrality no later than 2045 and reducing anthropogenic emissions by at least 85% below 1990 levels by 2045. Figure 2 puts all the numerical targets in statute into context.

Figure 2: California’s Historic GHG Emissions and Legislative GHG Reduction Targets



The Regulation establishes a declining limit on major sources of GHG emissions, and it creates a powerful economic incentive for significant investment in cleaner, more efficient technologies. The Program applies to emissions that cover approximately 80% of the emissions included in the State’s AB 32 GHG Emission Inventory. All entities covered by the Cap-and-Trade Program are still subject to their applicable air quality permit limits for criteria and toxic air pollutants. The Program is designed to achieve the most cost-effective statewide

GHG emissions reductions; there are no individual or facility-specific emissions reduction requirements. Each entity covered by the Regulation has a compliance obligation that is equivalent to its covered GHG emissions over a compliance period, and entities are required to meet that compliance obligation by acquiring and surrendering an equivalent number of compliance instruments. Compliance instruments include allowances and a limited number of compliance offset credits, which are issued to rigorously verified emissions reduction projects in sectors not covered by the Program. Like allowances, each offset credit is equal to one metric ton of carbon dioxide equivalent emissions.

The Program began to cover emissions in January 2013 and has achieved near 100% compliance rates for every compliance event to date. Allowances are issued by CARB and distributed both by free allocation – to minimize emissions leakage and to protect ratepayers – and by sale at quarterly auctions. Offset credits are issued by CARB to qualifying offset projects. Secondary markets exist where allowances and offset credits may be sold and traded among Program participants. Proceeds from the sale of State-owned allowances at quarterly auctions are placed into the GGRF and are appropriated by the Legislature during the annual budgeting process and consistent with State law to further the purposes of AB 32.

The Program is also designed to accommodate regional trading programs. Since 2007, California has been a partner in the Western Climate Initiative (WCI), an effort of U.S. states and Canadian provinces working together to implement policies to combat climate change, including through the development of a regional Cap-and-Trade system. Staff works with other WCI jurisdictions to ensure that rigorous and compatible systems are being developed. This cooperation facilitates future Program linkages with other developing GHG reduction programs in the region. On January 1, 2014, California and Québec linked their respective Cap-and-Trade programs. On January 1, 2018, the Program linked with the Cap-and-Trade program in Ontario, Canada, and then subsequently de-linked due to policy changes in Ontario. The Program demonstrated its flexibility to adapt to rapidly changing linked Programs without incurring any adverse impacts to California regulated entities or California's ability to achieve its 2020 target.

Concurrent to the passing of AB 398, one additional significant piece of legislation was enacted — AB 617 (C. Garcia, Chapter 136, Statutes of 2017). This bill recognized the need for the State to continue to identify and effectively address concerns related to local air quality impacts, especially in the State's most vulnerable communities, and to provide more direct tools to assist the State and air districts in improving air quality.

Specifically, AB 617 provides direction to strengthen air quality monitoring and reduce air pollution at a community level in communities affected by a high cumulative burden of exposure to pollution. CARB has established the Community Air Protection Program and is taking comprehensive action with air districts, communities, and other stakeholders to achieve AB 617 requirements.<sup>7</sup> In addition, AB 617 requires CARB to develop a statewide strategy to reduce criteria pollutants and toxic air contaminants (TACs) in communities affected by high cumulative exposure burdens through approved community emissions reduction programs developed by local air districts, in partnership with residents in the affected communities. AB

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<sup>7</sup> See the [Community Air Protection Program webpage](#) for more information on AB 617 implementation.

617 did not alter the longstanding local air district permitting authority for stationary sources. However, the bill required CARB to establish a uniform system of annual reporting of criteria pollutants and TACs for the existing statewide air monitoring network, and expedite implementation of best available retrofit control technology in nonattainment areas. The Regulation for the Reporting of Criteria Air Pollutants and Toxic Air Contaminants (CTR) to implement statewide annual reporting of criteria air pollutant and toxic air contaminant emissions data from facilities became effective January 1, 2020, with amendments effective January 1, 2022.

The Cap-and-Trade Program is one of California's primary tools for driving statewide GHG emissions reductions, and the Proposed Amendments are designed to help achieve the reductions needed to meet the targets in SB 32 and AB 1279. Companion programs, such as the AB 617 Community Air Protection Program, help ensure that community-level air quality concerns are also addressed as the State progresses toward its ambitious climate targets.

## **B. Description and Statement of Need for the Proposed Amendments**

CARB staff are proposing to amend the Cap-and-Trade Regulation to reflect a range of objectives, from simple updates and revisions to improve Program implementation, to broader proposals that will further support California's climate targets. CARB staff is proposing amendments to the Cap-and-Trade Regulation to:

- Revise the 2025-2030 allowance budgets to increase Program stringency, and revise post-2030 allowance budgets that reflect AB 1279 requirements;
- Update industrial allowance allocation to protect against emissions leakage risk and incentivize low-carbon production within the State;
- Update utility allowance allocation, consignment, and revenue spending requirements to prioritize benefits for low-income ratepayers while preserving an accurate carbon price signal imparted through electricity rates;
- Minimize emissions leakage in the electricity sector and ensure compliance obligations are applied consistently to imported electricity;
- Replenish the Voluntary Renewable Electricity Reserve with allowances to recognize voluntary investments in renewable electricity beyond State requirements; and
- Reflect lessons learned and streamline implementation of the Program.

The analyses to evaluate Proposed Amendments includes an expectation that complementary policies will work as designed under ideal implementation conditions. We know factors such as local permitting, supply chain issues, and legal challenges to policies could hinder the ability of complementary policies to deliver any estimated reductions in covered sectors and potentially increase demand for allowances under the Cap-and-Trade Program. More importantly, the Program is a system of design elements that together send a steadily increasing price signal, while avoiding price shocks. As such, any changes to the design elements must be considered as part of the overall system and not in isolation, and the cumulative impacts of changes to design elements must be considered in the context of overall stability of the Program and need for a steadily increasing price signal.

## Revise Future Allowance Budgets

CARB established the annual 2021-2030 allowance budgets in regulatory amendments adopted in 2017 aligning with the 2017 Scoping Plan Update, which focused on achieving the SB 32 GHG emissions reduction target of 40% below 1990 levels by 2030. AB 1279 was signed in 2022 and sets a GHG emissions reduction target 85% below 1990 levels by 2045. The 2022 Scoping Plan Update lays out a path to achieve this 85% target and carbon neutrality no later than 2045. Importantly, the 2022 Scoping Plan Update demonstrated the need to reduce GHG emissions to 48% below 1990 levels by 2030 to be on track to achieve the mid-century targets. Concurrent to the development of the 2022 Scoping Plan Update, the annually updated AB 32 GHG Emission Inventory was adjusted to more fully incorporate third-party verified GHG emissions and correct for some errors. Staff are proposing to update the Program in response to legislative direction, the 2022 Scoping Plan Update, and the revised AB 32 GHG Emission Inventory.

The proposed changes to the Regulation are aligned with and support California's portfolio of climate change measures. In addition to AB 1279, Governor Newsom signed SB 905 (Caballero, Chapter 359, Statutes of 2022) and several other climate-related bills into law in 2022.<sup>8</sup> Specifically, there was a recognition that the goals in AB 1279 would need carbon dioxide removal strategies for emitters, natural and working lands, and direct air capture from ambient air. There is also a need to understand the interaction of the Program through 2030 with a potential post-2030 allowance budget. Large capital investments are informed by long-planning horizons and deeper decarbonization is critical to meeting the AB 1279 targets. The 2022 Scoping Plan Update laid out the need for all available tools — carbon capture; low-carbon hydrogen; a clean, affordable, and reliable electricity grid; and more. The Program covers GHG emissions from large sources (e.g., power plants and large industrial plants, like cement plants), upstream transportation fuel and natural gas suppliers, and all electricity consumed in state; thus, the Program will play a critical role in deploying these tools to decarbonize wide swaths of the State's economy. Adoption of low-carbon technology and clean fuels is already accelerating and will continue to do so due to complementary State and federal policies, including unprecedented financial incentives.

While this is encouraging and necessary progress, a strong carbon price signal imparted through the Cap-and-Trade Program will be needed to further decrease GHG emissions to meet the 2030 target identified by the 2022 Scoping Plan Update and to achieve the mid-century emissions reduction target of 85% below 1990 levels, as required by AB 1279. As reflected in the 2022 Scoping Plan Update, several key actions are needed to accelerate the pace of decarbonization in these sectors, such as:

- Large-scale production and deployment of low-carbon hydrogen as a fuel substitute in several sectors;
- A substantial increase in renewable electricity generation capacity;
- Deployment of CCS technologies across several sectors as a critical GHG abatement measure and scaling of carbon dioxide removal to reduce ambient CO<sub>2</sub> concentrations;

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<sup>8</sup> [Governor Newsom Signs Sweeping Climate Measures, Ushering in New Era of World-Leading Climate Action | California Governor](#)



- Procurement of renewable natural gas as a fuel substitute in industrial sectors and feedstock for clean energy; and
- Accelerating the deployment of industrial heat pumps and other low and zero-emission technologies to support industrial decarbonization.

A stronger Cap-and-Trade Program price signal along with complementary policies and incentives will be necessary to facilitate these actions within the timeline contemplated by the 2022 Scoping Plan Update. The proposed changes to Program caps analyzed in this SRIA are designed to drive the needed progress. CARB staff is proposing to remove 264 million total allowances from the cumulative 2025-2030 budgets, adjusting these annual allowance budgets downward to account for prior year AB 32 GHG Emission Inventory adjustments (about 118 million allowances) and making further downward adjustments to support the 48% below 1990 level by 2030 GHG emissions reduction target put forth in the 2022 Scoping Plan Update. The Program also has a 5% pool of banked allowances to draw from to help smoothly transition into a more stringent 2030 target and avoid any potential price spikes. Additionally, CARB staff is analyzing new 2031-2045 Program annual allowance budgets to reflect a linear decline from the accelerated 2030 target to the 85% GHG emissions reduction target for 2045. These post-2030 allowance budgets support California's progress toward the targets in AB 1279 while providing certainty to regulated entities on Program design at the end of this decade. Post-2030 budgets will be invoked as early as 2028 for allowances offered in Advance Auctions, and Cap-and-Trade market participants will need to plan for auction participation and compliance strategies as the Program nears critical end-of-decade compliance periods. Clarity sooner than later on a post-2030 Program will allow for a smooth transition into the next decade and avoid investment uncertainty and potential allowance price volatility as was present in 2016 during the discussions for a post-2020 Program. Staff is proposing these amended Program budgets after a robust pre-rulemaking stakeholder engagement process that included public workshops where CARB staff presented and discussed multiple scenarios for potential adjustments to Program allowance budgets (see Analysis of Alternatives).

### **Updates to Industrial Allowance Allocation**

The purpose of industrial allocation is to minimize emissions leakage in accordance with AB 32 requirements by incentivizing efficient, in-state production from facilities in emissions-intensive, trade-exposed sectors. CARB staff is proposing amendments to eligibility criteria and calculation methods for determining allowance allocation to industrial facilities. Staff is proposing updates to definitions of certain covered products that are used to determine the amount of output-based allowance allocation for certain industrial facilities. The proposal also includes updates to allowance allocation benchmark for several industrial sectors to reflect new products and to incentivize emerging lower-carbon products.

The California Public Utilities Commissions (CPUC) oversees a process whereby investor-owned electric utilities provide output-based bill credits to covered industrial facilities to minimize the leakage risk associated with Program costs in purchased electricity. To streamline this process, CARB staff is proposing to replace the process overseen by CPUC by a process where CARB directly provides allowance allocation to covered industrial facilities to minimize the leakage risk associated with Program costs in purchased electricity.

CARB staff is also considering a new form of industrial allocation to minimize emissions leakage and incentivize GHG emissions abatement actions in hard to abate sectors, such as electrification of natural-gas-fueled industrial processes or procuring low-carbon energy. This industrial incentive allocation provides allowances to support GHG emission reductions while keeping efficient industrial production in California, and aligns with the industrial decarbonization strategy outlined in the 2022 Scoping Plan Update, which showed that:

- Where technically or commercially feasible, cost barriers limit needed widespread electrification of industrial processes; and
- Limited supplies of certain replacement fuels like biomethane or low-carbon hydrogen should be prioritized for sectors where direct electrification may not be feasible.

### **Updates to Utility Allocation, Consignment, and Revenue Spending Requirements**

CARB staff is proposing to update 2025-2030 allowance allocation for Electrical Distribution Utilities (EDUs) to reflect the 60% Renewable Portfolio Standard (RPS) in 2030 pursuant to SB 100 (De Leon, Chapter 312, Statutes of 2018) RPS procurement targets and newly available data from the California Energy Commission’s 2022 Integrated Energy Policy Report (CARB 2023e). EDU allowance allocation is designed to address the anticipated Program cost burden for each utility. Since EDU allowance allocation is set in advance,<sup>9</sup> individual utilities may be over- or under-allocated depending on how the actual electricity load or generation mix matches projections. More recent data and policy evolution shows that changes to 2025-2030 EDU allocation are needed to more accurately reflect the expected Cap-and-Trade Program cost burden in coming years.

Staff are also proposing to require EDUs that are publicly owned utilities (POUs) to consign all their allocated allowances to auction and spend the resulting proceeds on projects that benefit ratepayers. Currently, POUs can choose whether to consign their allocated allowances to auction or to use some or all allocated allowances directly for Program compliance. Staff used the historic proportions of allocated allowances used by POUs for Program compliance or for auction consignment to project the changes in future proceeds and compliance costs associated with full consignment.

### **Replenish the Voluntary Renewable Electricity Allowance Reserve**

CARB staff is proposing to place a total of approximately 5.5 million additional allowances from 2025-2030 annual budgets into the Voluntary Renewable Electricity (VRE) Reserve account. The VRE Program recognizes investments in renewable electricity generation beyond what is required by the RPS, supporting the transition of the electricity sector to 100% zero-carbon generation by 2045, as mandated by SB 100. Adding allowances to the VRE Reserve account is essential to continue the VRE Program, as allowances currently available in the VRE Reserve account are projected to be exhausted in the next few years.

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<sup>9</sup> Current 2021-2030 EDU allowance allocation is listed in Table 9-4 of the Regulation.

## Other Amendments

CARB staff is also proposing other changes to the Cap-and-Trade Regulation to streamline Program implementation and ensure consistent application of the Regulation, such as changes to market monitoring rules, updated compliance offset protocols, and clarified compliance requirements for imported electricity. These changes are informed by CARB's implementation experience and recent development in electricity markets and are not expected to have direct impacts on Program costs.

### C. Major Regulation Determination

Any agency that anticipates promulgating a regulation that will have an economic impact on California business enterprises and individuals in an amount exceeding \$50 million in any 12-month period between the date it is filed with the Secretary of State through 12 months after it is fully implemented (defined as major regulation) is required to prepare a SRIA.<sup>10</sup> The Proposed Amendments to the Cap-and-Trade Regulation would be fully implemented in 2045 and are estimated to result in an annual economic impact exceeding \$50 million starting in 2025. CARB staff analysis estimates that the Proposed Amendments could increase average direct annual costs to regulated entities by approximately \$3.7 billion per year between 2025 and 2046 (the full implementation timeline of the amended Regulation, plus one year).

### D. Baseline Information

The Baseline for this analysis assumes status-quo Cap-and-Trade Program implementation, which reflects the existing Program allowance budgets through 2045 and none of the other regulatory amendments outlined above. The Baseline also accounts for complementary policies assumed to contribute to the State's GHG emissions reduction targets for 2030 and 2045, as reflected in emissions modeling conducted for the 2022 Scoping Plan Update. Although the Program imparts an economy-wide carbon price that extends to transportation fuels and residential/commercial energy use, this SRIA assumes the GHG emissions benefits, the criteria pollutant emissions benefits, and the associated health benefits from those sectors are achieved by complementary measures. However, *costs* from Program compliance regardless of the existence of complementary policies are included in this SRIA. In this way, the SRIA analysis includes all estimated compliance costs (including costs that may result from the existence of complementary policies) but only the benefits that can be directly attributed to the Program. Staff analysis used Appendix C of the 2022 Scoping Plan Update to determine which decarbonization measures and sectors are attributed to the Proposed Amendments to the Cap-and-Trade Program in this SRIA.<sup>11</sup> CARB staff analysis assumes the amended Program allowance budgets will drive GHG emissions reductions from the industrial sector,

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<sup>10</sup> See Cal. Code Regs., tit. 13, § 2001, et seq.

<sup>11</sup> Decarbonization measures are identified in Appendix C of the 2022 Scoping Plan Update (CARB 2022b), and specific actions to achieve those measures are described in Table 2-1 of the 2022 Scoping Plan Update (CARB 2022a). The resulting GHG emissions associated with these actions for the Scoping Plan Scenario form the basis for the GHG emissions associated with the Proposed Scenarios. The measure, compensate for remaining emissions (carbon dioxide removal), is necessary to achieve carbon neutrality but does not contribute to achieving the SB 32 or AB 1279 GHG emissions reductions targets. This measure is not reflected in the Proposed Scenarios, Baseline, or alternatives in this SRIA.

from electricity generation, and from buildings where reductions are not otherwise achieved through zero-emission and decarbonization targets.

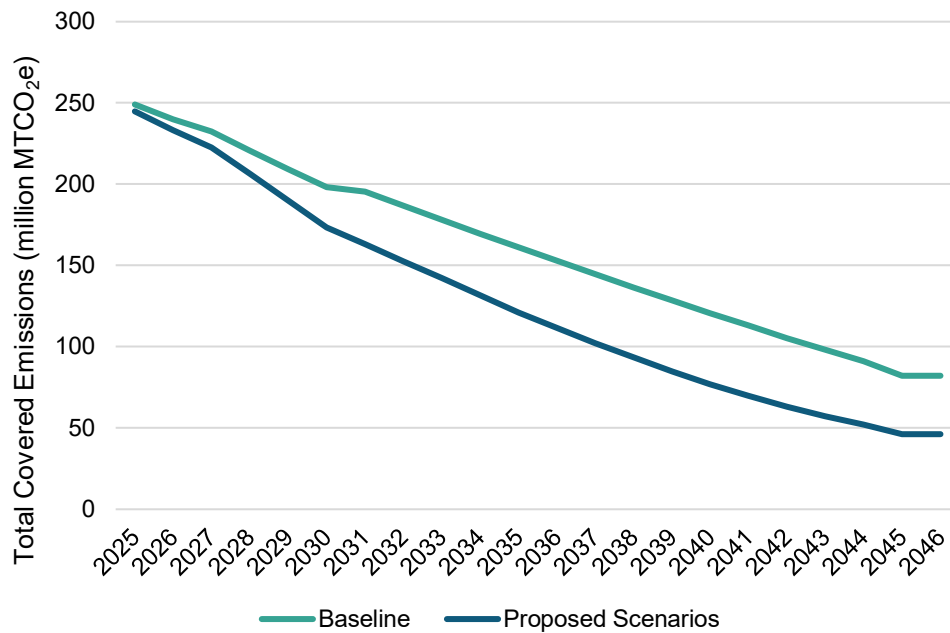
### **Covered Emissions**

Covered emissions are GHG emissions subject to the Cap-and-Trade Program (i.e., emissions from facilities and upstream fuel suppliers that emit more than 25,000 MTCO<sub>2</sub>e annually and all imported electricity emissions). Covered entities are required to obtain and retire a number of Cap-and-Trade compliance instruments (allowances and a limited number of compliance offset credits) equal to their covered emissions. To estimate covered emissions in the Baseline Scenario, the analysis started with 2021 MRR data (CARB 2022c) and the Scoping Plan Scenario from the 2022 Scoping Plan Update modeling<sup>12</sup>, which demonstrates a path to carbon neutrality by 2045. Scoping Plan sector-level emissions trajectories were then adjusted to reflect the current Cap-and-Trade Program allowance budgets (i.e., the Baseline). Each Cap-and-Trade covered facility was mapped to Scoping Plan sector categories to derive facility-level projected covered emissions for future years, and facilities were assumed to exit the Program as their projected covered emissions drop below the 25,000 MTCO<sub>2</sub>e threshold for an entire compliance period. Under this Baseline Scenario with current Cap-and-Trade Program allowance budgets, covered emissions reflect a trajectory needed to meet the statutory 40% GHG reduction target by 2030, but after 2030, the GHG emissions trajectory in the Baseline Scenario does not achieve carbon neutrality by 2045. Figure 3 compares projected covered emissions in the Baseline Scenario and Proposed Scenarios. During 2025-2046, cumulative covered emissions in the Baseline are approximately 3.5 billion MTCO<sub>2</sub>e.

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<sup>12</sup> The 2022 Scoping Plan Update modeling reflects model calibrations with the MRR data which is now more fully reflected in the AB 32 GHG Inventory.

Figure 3: Projected Cap-and-Trade Covered Emissions by Regulatory Scenario



The Cap-and-Trade Program’s covered emissions include emissions from many sectors. Several of these sectors are regulated by other California regulations such as the Low Carbon Fuel Standard (LCFS), Advanced Clean Cars II, Advanced Clean Fleets Regulations, or are targeted under plans such as the State Implementation Plan for federal Clean Air Act compliance. The Baseline Scenario covered emissions account for emission reductions that will be achieved through complementary policies.

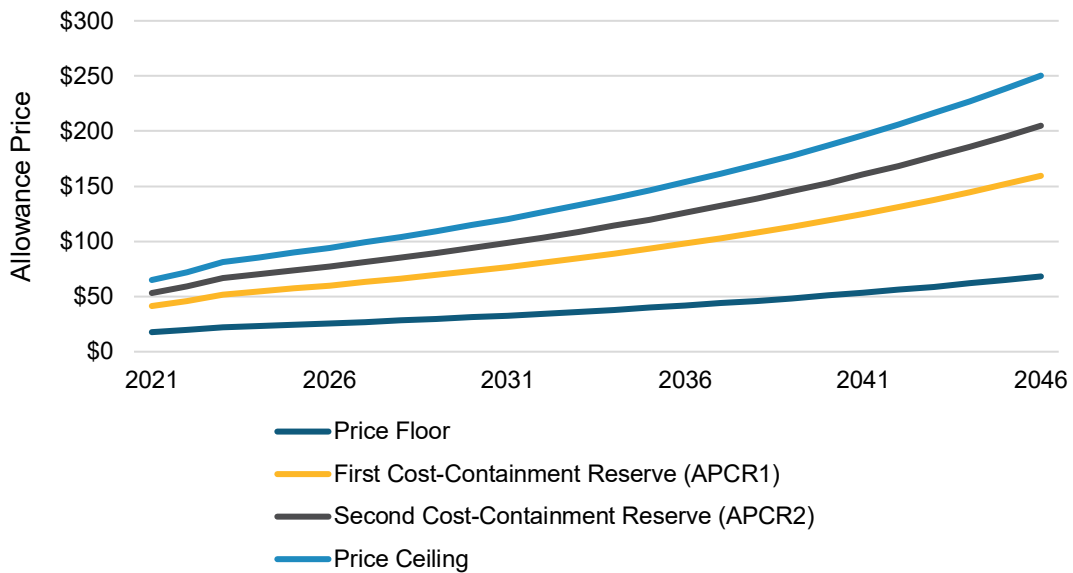
To isolate the impacts of the Proposed Amendments, the analysis identified sectors for which covered emissions are also affected by other programs and held covered emissions constant among the Baseline Scenario and other evaluated scenarios. These sectors are primarily transportation fuels, oil and gas extraction, and most residential and commercial energy use. Thus, the difference in covered emissions inputs (and corresponding GHG emissions benefits) between the Baseline Scenario and other scenarios is shown to occur only in a subset of sectors included in this analysis (i.e., industry, refineries, electric power, and some remaining fossil fuel use for buildings).

### Allowance Prices

To estimate future allowance prices, the analysis accounted for the various sources of compliance instruments available in the Baseline Scenario. After accounting for compliance offsets (subject to the offset usage limit), free allowance allocation used directly for compliance, and the existing unused allowances held in entity accounts, the number of allowances that covered entities will need to purchase at auction to cover outstanding Baseline Scenario covered emissions during 2025-2046 is approximately 2.4 billion. Each of the 2.4 billion remaining allowances needed for 2025-2046 Baseline Scenario covered emissions will be acquired at auction at a price bounded by the auction price floor and price ceiling. The Program also includes a pool of allowances set aside in the Allowance Price Containment

Reserve Account (APCR). If auction prices rise to a pre-determined level, allowances in the APCR are made available for sale at two intermediate price tiers to contain Program costs. These four prices — the auction floor price, the two APCR tier prices, and the ceiling price — each increase each year by 5% plus the rate of inflation (Figure 4). Staff is not proposing to make any changes to the APCR or price ceiling as part of the modeling included in this SRIA. Depending on additional modeling and stakeholder input, staff may need to adjust the APCR and price ceiling curves to remain in alignment with the direction in AB 398. Staff may also need to consider how borrowing from future year, post-2030 budgets could help to reinforce the APCR tiers.

Figure 4: Regulatory Allowance Price Tiers by Year. Actual values are shown for 2021 through 2023, and projected values are shown for 2024 through 2046.



Prices at any given future auction are inherently uncertain and are affected by numerous external factors, such as macroeconomic conditions, abatement costs, the broader state policy environment, evolving available technologies, and expectations of future prices. Allowance prices are also inherently a function of demand: if emissions are high, then demand for allowances will be high and prices will rise in response; and, in turn, a higher price incentivizes more expensive marginal emissions abatement projects, which reduces emissions and moderates prices.

Under the Baseline Scenario, where CARB does not increase the stringency of Cap-and-Trade Program allowance budgets, staff analysis assumes average allowance prices to be lower than under the Proposed Scenarios and alternative scenarios. For purposes of estimating allowance price costs for the analyses in this SRIA, staff analysis assumes that Baseline allowance prices track the auction floor price during 2025-2046. For the Proposed Scenarios and the evaluated alternatives, staff assumes higher average prices, at least in the short-run, as covered entities plan for and make business decisions under a more stringent Cap-and-Trade Program and a more constrained future allowance supply. Weighted-average allowance prices assumed for each scenario are included in Appendix A, Table 50.

## GHG Emissions Abatement

The scope of this analysis includes the cost of a subset of GHG emissions abatement technologies since abatement actions will be taken to avoid Program compliance costs. Staff analysis estimates these costs using a real-world understanding of the abatement options available to industrial facilities, including low-carbon hydrogen, biofuels, and electrification of process heat. There may be other efficiencies or abatement opportunities within sectors that are not fully known to the broader market but could be pursued under the Program. The amount of abatement assumed for each scenario tracks the projected change in sector-level covered emissions from current levels. Relative to the Baseline Scenario, each scenario evaluated shows higher average allowance prices, which supports adoption of more expensive abatement options (e.g., heat electrification) and leads to more total GHG emissions abatement. Abatement costs for the electricity sector are derived from 2022 Scoping Plan Update modeling and match the total amount of renewable generation capacity the State must add to accomplish broad electrification of other sectors, such as transportation. This amount of generation capacity does not vary across the evaluated scenarios. For each scenario, staff analysis assumes that facility-level CCS will be applied only at refineries as the SB 905 framework for carbon dioxide removal does not currently exist, but there is a CCS Protocol included in the LCFS Program.<sup>13</sup> Projected abatement costs relative to the Baseline are discussed further in Section III.A.

## E. Public Outreach and Input

Staff has been engaging with the public on potential future changes to the Cap-and-Trade Program. From June 2023 through March 2024, CARB staff conducted four public workshops in addition to numerous meetings with individual stakeholders to discuss concepts for potential Cap-and-Trade Regulation amendments to address various concerns. Two of the workshops were held jointly with the Québec Ministry of the Environment, the operator of the Québec Cap-and-Trade System that is linked with California's Cap-and-Trade Program. During the second joint workshop, two separate modeling teams, one contracted by CARB and the other an internal team from the government of Québec, presented initial results from independent modeling efforts for allowance prices under different allowance budget scenarios. Staff also held two community listening sessions to give interested parties additional opportunities to hear an overview of the Program and to provide input to staff about potential changes to the Program. Presentation materials for the community meetings were made available in both English and Spanish, the meetings were interpreted from English to Spanish, and video recordings of the meetings are publicly posted in both English and Spanish. Table 2 provides an overview of the public workshops and community meetings held in support of potential revisions to the Cap-and-Trade Regulation.

All workshops and community meetings were held virtually to enable access and wide participation through remote attendance. About two weeks prior to each event, a notice for the workshop was emailed to subscribers of CARB's "Cap-and-Trade Program," "Climate Change," and "GHG Mandatory Emissions Reporting" listservs. About 30,500 individuals or companies were notified for each workshop/meeting through the existing subscription lists.

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<sup>13</sup> See the [LCFS CCS Protocol](#) for more information.

Materials for public workshops and community meetings, including staff presentations, were posted to CARB's Cap-and-Trade Meetings and Workshops webpage prior to the workshops.<sup>14</sup> During each workshop, staff presented concepts for public consideration and provided opportunities for stakeholders to provide verbal feedback during the workshop and written public feedback for at least two weeks following the workshop. All workshop recordings and written public feedback are accessible through CARB's Cap-and-Trade Program Meetings and Workshop webpage.

Meetings were attended by covered entities, including representatives from natural gas and electrical utilities, industrial facilities, and transportation fuel suppliers; community members; environmental organizations; environmental justice groups; carbon market observers; voluntary carbon market participants; academics; consultants; and members of the public. These individuals and groups engaged by participating in workshops and meetings, providing data, and submitting written feedback on potential allowance budget scenarios and other initial concepts. Public input through the pre-rulemaking public process was used to develop, inform, and refine staff proposals. This also included input on alternative scenarios, as required under the SRIA process.

As mentioned earlier, CARB held two Cap-and-Trade Program virtual Community Meetings in fall 2023,<sup>15</sup> which included an AB 32 Environmental Justice Advisory Committee (EJAC) presentation.<sup>16</sup> The EJAC presentation included three key recommendations:

- Eliminate free allowances;
- Eliminate offsets; and
- Restrict trading in priority environmental justice communities.

Staff were not able to model the design changes provided in the meetings but are continuing to evaluate tools for further analysis. An initial qualitative discussion follows.

AB 398, which informs the current Program design through 2030, provides direction on free allowances and offsets. AB 398 does not include any provisions to support trading limits and limits on trading would be inconsistent with an aggregate cap as mentioned in AB 398 and direction on cost-effectiveness. If any future changes are considered, it is important to understand the role these design features play in the current Program, consistency with any relevant statutes, and the implications if changed moving forward. Since the Proposed Scenario in this SRIA is already proposing to remove some supply of allowances before 2030, Program design features, such as offsets for cost-containment, free allocation for minimizing leakage, and trading restrictions, must be considered in the context of a more stringent Program and not in the context of the existing Program as it stands today. They must also be considered together as part of a system, where their collective impact can matter more than their individual impact. For example, the Proposed Scenarios reduce allowance supply. Discontinuing the use of any offsets would further limit compliance instruments and put further

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<sup>14</sup> [Cap-and-Trade Meeting and Workshops webpage](#)

<sup>15</sup> [Cap-and-Trade Meetings & Workshops | California Air Resources Board](#)

<sup>16</sup> [EJAC Cap-and-Trade Concerns and Recommendations](#)



upward pressure on allowance costs, which increases the emissions leakage risk, and discontinuing free allowances could further exacerbate the potential for emissions leakage.

Free allowances are currently provided to electric and gas utilities for ratepayer benefit and to industry to minimize emissions leakage. The number of allowances allocated for free declines each year. The allowances provided to investor-owned electric and gas utilities are consigned each year at the quarterly auctions with revenue returned to ratepayers as a climate credit on their utility bills twice per year for electric utilities and once per year for gas utilities.<sup>17</sup> These California Climate Credits are meant to minimize energy cost impacts to Californians related to the implementation of the Cap-and-Trade Program. The state's ambitious goals to have a more resilient, clean, and affordable electricity grid warrants a careful approach to any changes in the climate credit for ratepayers, especially low-income households.

The free allowances provided to industry are designed to minimize emissions leakage per AB 32 and AB 398. Providing some number of free allowances for minimizing leakage is a common feature of most carbon pricing programs that cover industrial sources throughout the world.<sup>18</sup> AB 398 recognized that the 2021 through 2030 decade would see an ongoing and steepening reduction in allowance supply, which could increase prices for allowances and increase the potential for emissions leakage. AB 398 also requires CARB to report to the Legislature in 2025 on the progress toward meeting GHG reduction targets and on the leakage risk posed by the Regulation. This includes assessing the potential for a border carbon adjustment, where imported products would face some type of carbon liability similar to the carbon pricing faced by in-state production. Key considerations under a potential carbon border adjustment feature include the ability to adequately understand the carbon embedded in products received from global markets and interaction with any World Trade Organization agreements. It's also important to recognize not all industry faces the same potential for emissions leakage, and an approach to minimizing emissions leakage that is supported by data and more nuanced than simply eliminating free allocation for all industrial sectors is needed. For example, the refining sector was not classified as high risk for leakage in the initial regulation adopted in 2011. Moreover, removing free allocation before replacement with some other mechanism to minimize leakage could have greater impacts on some industries, state and local economies, and jobs under a more stringent Program as proposed in this SRIA.

The offsets<sup>19</sup> feature of the Program also has legislative direction on usage limits and direct environmental benefits to the state per AB 398. Importantly, the compliance offset program has served as an important cost-containment feature of the Program where costs for compliance offsets are historically slightly lower than the costs for allowances (CARB 2024). The compliance offset program also financially supports action to reduce GHG emissions outside of

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<sup>17</sup> [California Climate Credit](#)

<sup>18</sup> See the free allocation approach to emissions-intensive trade-exposed industries under [Washington State's Cap-and-Invest Program](#), [Québec's Cap-and-Trade System](#), and the [EU ETS](#).

<sup>19</sup> The design of the compliance offset program has been successfully litigated. *Our Children's Earth Foundation v. California Air Resources Board* (1st Dist. 2015) 234 Cal.App.4th 870 (upholding *Citizens Climate Lobby and Our Children's Earth Foundation v. California Air Resources Board* (2012) Case No. CGC-12-519554; 2013 WL 861396) (petition for review by California Supreme Court denied June 10, 2015)

the sectors directly covered by the Cap-and-Trade Program. This includes projects to sustainably manage natural and working lands to increase carbon sequestration, to capture and destroy fugitive emissions from high global warming gases, and to reduce fugitive methane emissions from mines and livestock operations. These actions are supported by the regulated entities that buy offsets and require no public monies. As part of the state's compliance offset program, tribal forestry projects have emerged as a meaningful way for tribes to participate in the Cap-and-Trade Program and generate revenue that is used to benefit their members. Any restriction on offset use needs to consider impacts to compliance costs, stranded investments for existing projects, and reduced funding opportunities for reducing GHGs from non-covered sectors and for sequestering carbon in natural and working lands.

The final recommendation from the Environmental Justice Advisory Committee presentation is to establish trading restrictions for stationary source emitters in disproportionately impacted communities. These sorts of provisions would effectively reduce the size of the market and could erode the benefits of a well-functioning market program, such as cost-effectiveness, liquidity, and price transparency, thus increasing the potential for both market manipulation and higher costs for electricity, gas, and transportation fuel suppliers who market or import energy for in-state consumption but may not own covered facilities in disproportionately impacted communities in the state. Staff analysis of the covered entities indicates that, out of approximately 400 covered entities, about 250 are stationary source facilities. The remainder are fuel suppliers and electricity providers. While the Program allows voluntary participants to support liquidity and price transparency, under this restricted trading approach, the number of entities that must acquire allowances for Program compliance and that could continue to participate in market trades would be reduced by over one-third. As any part of potential trading restrictions, a change in the size of the compliance market needs to be evaluated and understood for potential adverse impacts, such as price transparency and volatility.

Replacing a trading program with a different policy with no trading for a subset of the approximately 250 covered facilities will require consideration of several factors. About 50% of the approximately 70 covered power generating facilities are in disadvantaged communities (DACs). Currently, SB 100 calls for 100% clean electricity by 2045. Furthermore, power plants fall under the authority of Federal Energy Regulatory Commission, which ensures reliable, safe, secure, and economically efficient energy for consumers at a reasonable cost.<sup>20</sup> In the refining, hydrogen production, and oil and gas sectors, about 65% of the approximately 60 covered facilities are located in DACs. Only one of the remaining seven covered cement plants is located in a DAC. SB 596 (Becker, Statutes of 2021) requires CARB to develop a comprehensive strategy for the cement sector in California to achieve a GHG emissions intensity 40% below baseline levels by 2035 and net-zero GHG emissions by 2045. Similar information would need to be reviewed for California's wide variety of other industrial sectors, including food production, glass and metals manufacturing, and pulp and paper production. Approximately 60% of all covered facilities are located in DACs.

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<sup>20</sup> [Federal Energy Regulatory Commission \(ferc.gov\)](https://www.ferc.gov)

If there is no free allocation and no trading, the potential for emissions leakage is further potentially increased relative to the Proposed Scenarios for most industrial sectors. The Program would need to incorporate both a new mechanism to mitigate any increased leakage risk and a new method to ensure non-trading facilities take action to reduce emissions. One potential option to ensure emissions reductions would be to apply a declining facility-specific GHG emissions reduction target to each non-trading facility. Annual facility reduction targets could be derived from the decline in Program annual budgets, which is about 8% per year from 2025 to 2030 and about 9% per year from 2031 to 2045 under the Proposed Scenario B. That is one of a range of potential options for establishing annual reduction targets. Currently, the cap decline for this decade is approximately 4% per year.

If there were free allocation but no trading, the amount of freely allocated allowances could be aligned with facility-specific reduction targets with the option to buy additional allowances only from auctions, but with some limits to ensure expected reductions actually take place at a given facility. If annual facility targets were informed by in-state production, in order to minimize emissions leakage risk, it may be difficult to set annual facility targets in advance of emissions years due to the need to use the most recent reported and third-party verified data currently used for free production-based allocation. This approach could add new considerations for near- and long-term investment planning for facilities. It may increase overall auction prices, as covered entities with trading restrictions have no source other than auctions from which to procure allowances, thus increasing compliance costs for all entities, increasing the potential for leakage, and increasing economy-wide costs to California consumers. Importantly, if freely allocated allowances served as a definite facility emission limit rather than a target, these entities would not be allowed to participate in auctions and acquire allowances beyond their defined emission limit.

A subset of facilities that are prohibited from trading and subject to any decreasing facility-specific limit annually, or over short time frames, will need readily available options to increase efficiency or reduce onsite emissions to comply. In the absence of options to increase emissions efficiency in a timely manner while maintaining the same level of production, entities may need to reduce their production output to reduce their emissions. It is also important to design a path that does not disadvantage facilities that have already significantly invested in GHG emissions reductions and new facilities with innovative low-GHG processes, where there may be fewer opportunities to further reduce emissions from a starting benchmark. For some sectors, large investments may require permits or other approvals from various authorities that may not align with compliance timing for reducing emissions. Facility-specific limits could also bring the potential for shifts or increases in total in-state emissions across facilities within a sector. This could result from decreasing production in order to meet prescriptive emission limits at facilities located in DACs, with that needed production replaced by less efficient facilities in that same sector that are not located in DACs, thus increasing emissions at the non-DAC facilities. Facilities not located in DACs may, or may not, be as efficient as the facilities in DACs which would determine total state-level emissions impacts.

Any policy that incorporates no trading provisions (which translates to facility caps) must be evaluated to better understand the potential abatement outcomes, costs, compliance, and emissions leakage impacts for impacted facilities and sectors and the Program as a whole. Regardless, all facilities would remain subject to limits on harmful air pollution imposed through

permits administered by local air districts, as is the case under the Proposed Scenarios and long-standing permitting process in the state.

Table 2: Cap-and-Trade Public Workshops

Workshop	Date	Location	Time	Number of Comment Letters Received
Presented the status of the Cap-and-Trade Regulation, scope of potential amendments, and evaluations to inform potential regulatory amendments to align with the 2022 Scoping Plan Update. (Joint California-Québec workshop)	June 14, 2023	Virtual via Zoom	8:30 am-11 am	30
Introduced framework to explore more stringent cumulative 2021-2030 allowance budgets and solicited alternatives. Also discussed industrial allowance allocation and the use of allowance value by natural gas suppliers and electrical distribution utilities.	July 27, 2023	Virtual via Zoom	9 am – 12 pm	53
Reviewed 2030 allowance budget scenarios and discussed potential post-2030 budgets. Also discussed updates to EDU allocation and cap adjustment factors and topics relevant to the treatment and reporting of electricity imports and biogenic emissions exemptions.	Oct. 5, 2023	Virtual via Zoom	9:30 am - 4 pm	56
Community meeting for community members to hear a Program overview and to provide input about potential changes to the Program. An invited speaker also shared an environmental justice perspective on the Program.	Oct. 30 and Nov. 7 2023	Virtual via Zoom	6 pm – 8 pm	1
Presentation of third-party modeling of allowance prices under different allowance budget scenarios. Also discussed concepts related to joint-market rules and cost-containment. (Joint California-Québec workshop)	Nov. 16, 2023	Virtual via Zoom	9:30 am – 12:30 pm	27

The modeling and direction in the 2022 Scoping Plan Update, evolving State policy, implementation experience, and updates to the AB 32 GHG Emission Inventory have all informed the development of potential Program updates and initial concepts presented during public workshops and community meetings. In addition, CARB staff participated in numerous stakeholder meetings requested by other parties, presenting information on the implementation of the existing Regulation, and exploring potential amendments.

The Cap-and-Trade Program website has been continually updated since the beginning of the Program to facilitate public participation, enhance transparency, and ensure equal access to Program market information for all interested parties. Staff has consistently made materials related to this rulemaking available online, including workshop notices, meeting presentations, meeting recordings, and comment letters submitted by stakeholders in response to meetings and workshops. The website also provides background information on the Cap-and-Trade Program, previous workshop notices and materials, public Program data, guidance documents for covered entities and market participants, and all formal documents associated with previous rulemakings.

CARB staff will continue to accept public feedback, including in public comments that staff will invite on the rulemaking proposal, as well as through engagement at public workshops and Board meetings, and will continue to consider input to the rulemaking proposal based on stakeholder input. The updated estimated economic impact of a final proposal, if adopted (including any modifications to the current proposed amendments that occur during the regulatory process) will be analyzed in the Economic and Fiscal Impact Statement (STD 399) submitted to the California Department of Finance (CDF) and Office of Administrative Law (OAL) with the final regulatory package.

## **II. Benefits**

### **A. Emission Benefits**

The Proposed Amendments to the Cap-and-Trade Regulation are designed to support achieving a 48% reduction in California's anthropogenic GHG emissions relative to 1990 levels by 2030, and an 85% GHG emissions reduction by 2045. Since Program allowance budgets represent the annual GHG emissions trajectory needed for the State to reach its targets, each allowance removed from the Program is assumed to reduce approximately one MTCO<sub>2e</sub> of GHG emissions from sectors that are responsive to the Cap-and-Trade Program allowance price.

The Proposed Amendments are also anticipated to increase the proceeds from the auction of State-owned allowances that are placed in the GGRF. The resulting increase in GGRF program expenditures will result in additional GHG emissions reductions from activities not otherwise covered by the Cap-and-Trade Program. Finally, staff analysis quantifies expected criteria pollutant benefits both from reduced GHG emissions at covered facilities and from increased GGRF expenditures in sectors not covered by the Cap-and-Trade Program.

Note that, for the purposes of this analysis, staff assume only one emissions reduction outcome associated with increased Program stringency for each of Proposed Scenario A, B, and C, due to the relationship between allowance removals and emissions reductions in Cap-and-Trade covered sectors (referenced as Proposed Scenarios in text and figures). However, expected emissions benefits from increased GGRF expenditures do vary as the monies to GGRF can vary under different Proposed Scenarios.

## **GHG emissions accounting methodology**

Since the 2022 Scoping Plan Update provides the basis for the GHG emissions reduction targets, staff analysis incorporates the GHG emissions modeling for the Scoping Plan Scenario to calculate the corresponding GHG emissions benefits of the Proposed Scenarios (CARB 2022a, CARB 2022d, CARB 2022e). The Scoping Plan Scenario presents modeling results for GHG emissions and energy demand by sector and by fuel type. To calculate projected future emissions under a regulatory scenario other than the Proposed Scenarios (i.e., the Baseline and the alternatives), staff analysis either added or subtracted emissions relative to the Proposed Scenarios to correspond to the scenario allowance budgets and then derived sector-level emissions trajectories that demonstrate the expected total GHG emissions reductions under the scenario needed to reach the scenario 2030 and 2045 targets. Emissions results associated with sectors and fuels attributed to other programs or regulations remain the same in the Baseline Scenario, the alternatives, and the Proposed Scenarios.

## **Anticipated GHG emissions benefits**

The projected GHG emissions benefits of the Proposed Scenarios are calculated as the difference in expected cumulative GHG emissions between the Baseline Scenario and Proposed Scenarios. These GHG emissions benefits are realized through abatement resulting in reduced use of fossil fuels, relative to baseline expectations.

GHG emissions attributed to other programs and regulations in this SRIA do not vary among the Baseline, the Proposed Scenarios, or the alternatives. For clean electricity generation, which is influenced by increased Program stringency, the total capacity of new renewables deployed to meet demand and reach carbon neutrality by 2045 is assumed to be constant among the Baseline Scenario and all scenarios and to align with the renewable generation capacity deployed in the Scoping Plan Scenario. For other measures attributed to increased Program stringency, GHG emissions reductions are achieved either through the electrification of thermal energy needs or through increased use of low-carbon fuels, such as biofuels or low-carbon hydrogen. The Baseline Scenario assumes deployment of these technologies in future years to reduce GHG emissions in line with the current allowance budgets, while the Proposed Scenarios and alternatives show additional deployment beyond baseline levels to match the more stringent allowance budgets. The Proposed Scenarios reduce GHG emissions by approximately an additional 106 million MTCO<sub>2e</sub> from 2025-2030 and 862 million MTCO<sub>2e</sub> from 2031-2046 due to increased Program stringency. These totals are calculated relative to the Baseline Scenario, i.e. they represent emissions reductions in excess of those that would have been achieved under status-quo Program implementation. Each of the three specific Proposed Scenarios (A, B, and C) provides the same amount of total GHG emissions benefits in capped sectors during 2025-2046.

The 2022 Scoping Plan Update shows that targeted deployment of CCS will be needed to reduce GHG emissions from several stationary sources that are difficult to mitigate through other abatement technologies (e.g., process emissions from cement manufacturing and emissions from remaining natural gas power plants needed for grid reliability). In alignment with the 2022 Scoping Plan Update, this analysis assumes deployment of CCS at refineries in all scenarios. Further deployment of CCS in other industrial sectors may occur concurrent to CARB developing a regulation for a Carbon Capture, Removal, Utilization, and Storage

Program per SB 905 but is not included in this analysis. Thus, the Proposed Scenarios should not be expected to result in GHG emissions reductions that meet the accelerated 2030 target in the Scoping Plan and the AB 1279 2045 target as not all emissions sources are covered by the Cap-and-Trade Program, and CCS is not broadly deployed across all sectors as was modeled in the 2022 Scoping Plan Update with an accelerated 2030 target. Overall, there is need to have policies in place to reduce emissions from uncapped sources and CCS as a compliance path for large emitters covered by the Cap-and-Trade Program to support the achievement of statewide targets.

While staff analysis assumes the proposed allowance budget updates will drive sufficient emissions reductions to help meet the 2030 and 2045 targets, the temporal relationship between allowance removals and emissions reductions will not necessarily directly align in any given year. Market factors such as allowance price expectations, current allowance holdings (i.e., the existing “bank” of unused allowances), the availability of abatement technologies and uncertainty of permitting wait times will influence when, exactly, allowance removals will produce the associated GHG emissions benefits (CARB 2022a). Given these factors, staff analysis assumes that the allowance removals associated with meeting the accelerated 2030 GHG target will drive GHG reductions prior to 2030 to help meet the 2030 target, and any additional allowance removals will produce GHG benefits after 2030. The AB 32 GHG Inventory and AB 32 Scoping Plan updates are critical to track progress towards the statutory targets and evaluate and consider if changes to any policies are warranted and that all sectors continue to see reductions in their GHG emissions.

#### *Increased GGRF Expenditures*

In addition to GHG emissions reductions from reduced fossil fuel combustion in covered sectors, the Proposed Amendments will also produce additional GHG emissions benefits from a projected increase in GGRF revenues. While GGRF revenues are appropriated by the Legislature as part of the annual budgeting process with the Administration for a wide variety of GHG emissions reduction projects, the GGRF emissions benefits claimed for these amendments are narrowly limited only to those GHG emissions reductions achieved in sectors that are not covered by the Program to address any potential double-claiming of GHG emissions benefits in this analysis. Assuming the historic apportionment of GGRF revenues continues in future years, staff analysis assumed additional GHG emissions reductions to occur as a result of the Proposed Amendments, as shown in Table 3. The range presented in Table 3 and Table 4 for projected GGRF appropriations for select non-regulated GGRF programs and emissions benefits is bounded by values for Proposed Scenario A and Proposed Scenario C.

Table 3: Non-Regulated Sector GGRF Program Projected Expenditures<sup>21</sup> with Additional GHG Benefits

<b>GGRF Non-regulated Sector Program Name</b>	<b>Projected GGRF Appropriation Increase (\$ million, 2025-2046)</b>	<b>Projected GHG Benefits Above Baseline (thousand MTCO<sub>2e</sub>, over project lifetimes)</b>
Climate Adaptation and Resiliency	\$7 - \$10	69 -100
Climate Ready	\$44 - \$64	2 -3
Forest Carbon Plan Implementation	\$58 - \$85	7 - 10
Heathy Soils	\$23 - \$34	266 - 385
Sustainable Forests	\$390 - \$565	10,020 - 14,500
Training and Workforce Development	\$31 - \$45	74 - 107
Urban and Community Forestry	\$3.6 - \$5.1	126 - 183
Urban Greening	\$56 - \$81	26 - 38
Wetlands and Watershed Restoration	\$16 - \$24	528 - 764
Woodsmoke Reduction	\$6.4 - \$9.3	52 - 75
<b>Total</b>	<b>\$636 - \$921</b>	<b>11,170 - 16,165</b>

The projected GHG emissions benefits from the Proposed Scenarios attributed to increased Program stringency and increased GGRF expenditures in the select non-regulated sectors are shown in Table 4. The GHG benefits of increased Program stringency (i.e., the benefits of a higher carbon price for Cap-and-Trade covered entities) do not vary among the Proposed Scenarios (A, B, and C) since each of these scenarios removes the same total number of allowances from future Program budgets.

Table 4: Total 2025-2046 GHG emissions benefits under the Proposed Scenarios

<b>Category</b>	<b>Total GHG Emissions Benefits, Relative to Baseline (million MTCO<sub>2e</sub>)</b>
Increased Cap-and-Trade Program Stringency	967 (2025-2046)
Increased GGRF Expenditures in select Non-Regulated Sectors	11-16 (over project lifetimes)

<sup>21</sup> Projections are derived from historic GGRF appropriations and reported GGRF program GHG benefits, as documented in data aggregated by California Climate Investments (CARB 2023c, CARB 2023d, CARB 2023e). See the [California Climate Investments Data Dashboard](#) for more information on GGRF program benefits.



## Anticipated criteria pollutant emission benefits

### *Increased Program Stringency*

California's Cap-and-Trade Program is designed to reduce statewide GHG emissions through a market mechanism that does not directly limit emissions for any specific facility or geography. However, by imparting an increased price on covered GHG emissions, staff analysis forecasts that the Proposed Scenarios will result in local air quality improvements as facilities and operations in sectors covered by the Program invest in efficiency improvements or switch to cleaner technologies. For petroleum refineries, industrial manufacturing facilities, and agricultural operations, the staff analysis assumes that any incremental decrease in facility-level GHG emissions among regulatory scenarios is attributable to a proportional decrease in on-site fuel combustion. The modeling also assumes some amount of CCS on the refining sector where the relationship between GHG and air quality reductions is not clearly understood or directly correlated<sup>22</sup>. There is emerging information that applications of CCS could also reduce harmful local air pollution (Brown et al. 2023)<sup>23</sup>. For residential and commercial buildings, the staff analysis does not claim criteria pollutant benefits due to the Proposed Scenarios, since fuel-switching to renewable natural gas or electrolytic hydrogen does not reduce overall fuel combustion and since electrification in these sectors is attributed to other programs. These assumptions for expected GHG emissions reduction measures are reflected both in the analysis of criteria pollutant emissions benefits and in the analysis of abatement costs, ensuring that the associated health benefits claimed for the Proposed Scenarios are commensurate with the expected costs of decarbonization.

The staff analysis of criteria pollutant emission benefits draws from 2022 Scoping Plan Update modeling data to convert facility-level GHG emissions reductions to corresponding decreases in fuel combustion. It then applies applicable emissions factors to convert the reduced fuel use to expected reductions in two key criteria pollutants, PM<sub>2.5</sub> and NO<sub>x</sub>, and the resulting criteria pollutant emissions benefits are presented in Table 5. Statewide criteria pollutant reductions are further disaggregated by California air basin by associating fuel reductions with the known geographic distribution of Program covered facilities and agricultural production within the State (Table 6).

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<sup>22</sup> Refineries can have a variety of point sources that emit CO<sub>2</sub>—such as steam methane reformers for producing hydrogen, combined heat and power units, and catalytic crackers—that are best suited for CCS. Each configuration of a refinery can be unique to its footprint, onsite operations, and the types of crude oils processed. There are newer technologies with smaller footprints that can be deployed in modular configurations to capture CO<sub>2</sub> in space-constrained and multiple-point-source facilities such as refineries. Assumptions of reductions in GHGs at a refinery with CCS rely on the same assumptions used in the 2022 Scoping Plan Update.

<sup>23</sup> Brown et al. 2023 evaluates the feasibility and emissions outcomes of hypothetical CCS projects on cement plants and petroleum refineries in California and Texas. The study concludes that these projects would significantly reduce facility emissions of both CO<sub>2</sub> and harmful co-pollutants such as particulate matter (PM) and sulfur dioxide (SO<sub>2</sub>), primarily because these pollutants must be removed from the flue gas stream for the carbon capture system to function effectively.

### *Increased GGRF Expenditures*

Marginal increases in GGRF revenue expenditures in non-regulated sectors are also expected to produce criteria pollutant benefits. Staff analysis examined the same subset of non-regulated sector GGRF programs where GHG emissions benefits are claimed for the Proposed Scenarios, calculated the historic geographic distribution of reported project-level PM<sub>2.5</sub> and NO<sub>x</sub> emissions reductions by California air basin, and applied this data to estimated future GGRF revenues for these select GGRF Programs to calculate the expected criteria pollutant benefits from additional GGRF expenditures under the Proposed Scenarios. These expected benefits are also included in Table 6. The inclusion of post-2030 caps allows advance auctions to continue where, at each quarterly auction, allowances from the current budget year and three years in advance are sold and all revenues deposited into the GGRF. This means beginning in 2028, the advance auctions would include some vintage 2031 allowances, pulled forward from the 2031 budget.

Table 5: GHG and Criteria Pollutant Emissions Benefits from Increased Program Stringency Under the Proposed Scenarios, Relative to the Baseline from 2025-2046

<b>Year</b>	<b>GHG Reductions (million MTCO<sub>2</sub>e)</b>	<b>NO<sub>x</sub> Reductions (short tons)</b>	<b>PM<sub>2.5</sub> Reductions (short tons)</b>
2025	5	2,270	250
2026	9	4,520	505
2027	13	6,770	765
2028	19	9,020	1,065
2029	26	11,345	1,475
2030	33	13,330	2,025
2031	44	16,695	2,680
2032	46	16,600	2,800
2033	49	16,460	2,910
2034	51	16,490	3,030
2035	54	16,565	3,165
2036	56	16,180	3,195
2037	58	16,070	3,200
2038	59	16,080	3,180
2039	59	16,535	3,155
2040	60	17,675	3,100
2041	59	18,040	2,915
2042	58	18,550	2,715
2043	56	19,145	2,485
2044	53	19,680	2,245
2045	51	11,985	1,945
2046	51	11,985	1,945
<b>Total</b>	<b>967</b>	<b>311,985</b>	<b>50,765</b>

Table 6: Total Criteria Pollutant Benefits by Air Basin for the Proposed Scenarios, Relative to the Baseline Scenario for 2025-2046

Air Basin	Benefits from Increased Cap-and-Trade Program Stringency (reduction in short tons)		Benefits from Increased GGRF Expenditures in Select Non-Regulated Sectors (reduction in short tons)	
	NOx	PM <sub>2.5</sub>	NOx	PM <sub>2.5</sub>
Great Basin Valleys	129	2	1.5-2.1	5-50
Lake County	167	3	0.8-1.2	21-31
Lake Tahoe	402	8	0.8-1.1	0.1-0.2
Mojave Desert	39,495	6,325	0.3-0.4	0.4-0.6
Mountain Counties	956	18	10-15	244-353
North Central Coast	15,725	1,635	6.0-8.7	78-113
North Coast	2,610	160	2.2-3.2	53-76
Northeast Plateau	1,445	40	2.3-3.3	50-73
Sacramento Valley	19,365	2,800	10-14	168-243
Salton Sea	8,850	425	0.6-0.9	(3.1)-(4.5)
San Diego County	8,020	1,295	1.8-2.6	0.5-0.8
San Francisco Bay	39,020	11,005	4.3-6.2	12-17
San Joaquin Valley	114,800	12,125	(1.1)-(1.6)	(0.5)-(0.8)
South Central Coast	13,000	900	3.2-4.7	30-44
South Coast	48,010	14,020	20-29	2.5-3.6
<b>Total</b>	<b>311,985</b>	<b>50,765</b>	<b>62-90</b>	<b>690-1000</b>

## B. Benefits to Typical Businesses

The Cap-and-Trade Program covers a wide variety of California businesses that face different compliance obligations depending on the emissions intensity of their operations, the availability of abatement options, and eligibility for free allowance allocation. Most covered entities will see a net increase in Program costs associated with higher allowance prices, and some sectors may see a decrease in allowance allocation resulting from the reduced overall annual allowance budgets. However, the Proposed Amendments also include a new form of allowance allocation to incentivize industrial decarbonization, which may reduce Program costs for certain eligible facilities. Depending on the cost and feasibility of decarbonizing their operations, some individual facilities could even see a net financial benefit from the Proposed Amendments through selling excess allowances on the secondary market.

## C. Benefits to Small Businesses

Because of the annual emissions threshold for Program coverage, small businesses generally do not incur a direct compliance obligation under the Program. However, small businesses may see an increase in energy costs from the pass through of some Program costs in utility rates, but measures such as energy efficiency and fuel switching may partially offset those increased costs. Under the Proposed Amendments, this cost increase will also be partially offset by a projected increase in IOU electric utility allowance allocation auction revenues

distributed through the Small Business California Climate Credit.<sup>24</sup> Some small businesses may also benefit from a marginal increase in GGRF revenues that are invested in Programs aimed to deploy low-carbon technologies and reduce GHG emissions at a community level.

## D. Benefits to Individuals

### GGRF and California Climate Credit

The Cap-and-Trade Program is designed to benefit all Californians through reducing GHG emissions that cause catastrophic climate change. While individuals do not participate directly in the Program, the financial costs of covered entities either paying Program compliance costs or decarbonizing their operations are generally passed through to consumers through an increase in the costs of goods and energy. The Program also includes multiple mechanisms to provide benefits to individuals:

- GGRF revenues accrued from the sale of state-owned allowances are appropriated by the Legislature in a variety of programs that directly benefit individuals and communities, and future GGRF revenues available for these programs are expected to increase under the Proposed Amendments (Table 7). GGRF benefits to individuals include electric vehicle incentives, investments in affordable and sustainable housing development, and funds for community air monitoring and local air quality improvements. GGRF programs are also designed to largely benefit priority populations, which are defined as either low-income communities and/or communities facing the highest levels of environmental pollution.<sup>25</sup> Increasing GGRF revenues will thus disproportionately benefit the most vulnerable Californians (see subsection E, Equity Considerations, for additional discussion of the distribution of benefits from the Cap-and-Trade Program). For the purposes of this analysis, staff analysis assumes that future GGRF revenues will be distributed to programs and industries in the same proportion as historic appropriations (CARB 2023f), though benefits accrue over the project lifetimes rather than in the same year that funds are appropriated.
- The residential California Climate Credit, which is disbursed directly to households on investor-owned utility bills, is derived from allowances allocated to natural gas and electricity IOUs and consigned to auction. Staff analysis assumes an increase in average annual utility auction proceeds as a result of higher allowance prices under the Proposed Scenarios (Table 8). Auction proceeds used for the residential California Climate Credit are split equally among each household in an IOU's service territory, such that each household receives the same credit amount. Since the credit is non-volumetric (i.e., it is not linked to the volume of electricity or natural gas consumed by a household), it provides some relief of Program costs passed through to consumers

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<sup>24</sup> See the [California Public Utilities Commission webpage](#) for more information on the Small Business Climate Credit.

<sup>25</sup> Specifically, [priority populations](#) are communities and households at or below 80% of median income, or census tracts scoring in the top 25% statewide on an average of health, environmental, and socioeconomic indicators identified by CalEnviroScreen.

without blunting the Program price signal in rates to incentivize energy conservation or fuel-switching.

Table 7: Expected Increase in Total GGRF Revenues under the Proposed Scenarios (\$ billion)

<b>Year</b>	<b>Baseline Revenue</b>	<b>Proposed Scenarios Revenue</b>	<b>Change in Revenue</b>
2025	\$3.7	\$5.6-\$6.1	\$1.9-\$2.3
2026	\$3.5	\$5.2-\$5.4	\$1.7-\$1.9
2027	\$3.3	\$4.8-\$4.9	\$1.5-\$1.5
2028 <sup>26</sup>	\$3.1	\$4.3-\$4.6	\$1.1-\$1.4
2029	\$3.0	\$3.8-\$4.3	\$0.8-\$1.3
2030	\$2.8	\$3.4-\$4.0	\$0.6-\$1.2
2031	\$2.7	\$3.5-\$4.0	\$0.8-\$1.3
2032	\$2.6	\$3.3-\$3.7	\$0.7-\$1.1
2033	\$2.5	\$3.1-\$3.5	\$0.6-\$1.0
2034	\$2.4	\$2.9-\$3.3	\$0.4-\$0.9
2035	\$2.3	\$2.7-\$3.0	\$0.3-\$0.7
2036	\$2.2	\$2.4-\$2.8	\$0.2-\$0.6
2037	\$2.1	\$2.2-\$2.6	\$0.1-\$0.4
2038	\$2.0	\$2.0-\$2.3	\$0.0-\$0.3
2039	\$1.9	\$1.8-\$2.1	(\$0.1)-\$0.2
2040	\$1.8	\$1.6-\$1.9	(\$0.2)-\$0.0
2041	\$1.8	\$1.4-\$1.7	(\$0.3)-(\$0.1)
2042	\$1.7	\$1.2-\$1.4	(\$0.4)-(\$0.2)
2043	\$1.6	\$1.0-\$1.2	(\$0.5)-(\$0.4)
2044	\$1.5	\$0.8-\$1.0	(\$0.6)-(\$0.5)
2045	\$1.4	\$0.6-\$0.7	(\$0.7)-(\$0.7)
2046	\$1.4	\$0.6-\$0.7	(\$0.7)-(\$0.7)
<b>Total</b>	<b>\$51.4</b>	<b>\$59.8-\$63.6</b>	<b>\$8.4-\$12.2</b>

<sup>26</sup> In 2028, vintage 2031 allowances will be made available for auction.

Table 8: Expected Increase in Utility Allowance Revenues for Ratepayer Benefit under the Proposed Scenarios (\$ billion)

Year	Baseline Revenue	Proposed Scenarios Revenue	Change in Revenue
2025	\$3.3	\$5.8-\$5.9	\$2.5-\$2.6
2026	\$3.2	\$5.3-\$5.4	\$2.1-\$2.3
2027	\$3.0	\$4.7-\$5.1	\$1.7-\$2.1
2028	\$2.8	\$4.2-\$4.8	\$1.3-\$1.9
2029	\$2.7	\$3.7-\$4.4	\$1.0-\$1.8
2030	\$2.5	\$3.3-\$4.2	\$0.8-\$1.7
2031	\$2.4	\$3.6-\$3.9	\$1.2-\$1.5
2032	\$2.3	\$3.4-\$3.6	\$1.1-\$1.3
2033	\$2.2	\$3.2-\$3.4	\$0.9-\$1.2
2034	\$2.2	\$3.0-\$3.2	\$0.8-\$1.0
2035	\$2.1	\$2.8-\$3.0	\$0.7-\$0.9
2036	\$2.0	\$2.6-\$2.7	\$0.6-\$0.7
2037	\$1.9	\$2.3-\$2.5	\$0.4-\$0.6
2038	\$1.8	\$2.1-\$2.3	\$0.3-\$0.5
2039	\$1.7	\$1.9-\$2.1	\$0.2-\$0.3
2040	\$1.7	\$1.7-\$1.8	\$0.1-\$0.2
2041	\$1.6	\$1.5-\$1.6	(\$0.1)-\$0.0
2042	\$1.5	\$1.3-\$1.4	(\$0.2)-(\$0.1)
2043	\$1.4	\$1.1-\$1.2	(\$0.3)-(\$0.2)
2044	\$1.3	\$0.9-\$0.9	(\$0.4)-(\$0.4)
2045	\$1.2	\$0.7-\$0.7	(\$0.6)-(\$0.5)
2046	\$1.2	\$0.7-\$0.7	(\$0.6)-(\$0.5)
Total	\$46.1	\$62.1-\$62.4	\$15.9-\$16.3

From an emissions perspective, the economic benefit to individuals from reduced GHG and criteria pollutants emissions in sectors attributed to the Program is estimated per the methodologies below.

### Social Cost of Carbon

The benefit of GHG reductions achieved by the Proposed Amendments can be estimated using the social cost of carbon (SC-CO<sub>2</sub>), which provides a dollar valuation of the damages caused by one metric ton of carbon pollution and represents the monetary benefit today of reducing carbon emissions in the future. The social cost of carbon is not the same as the cost of abatement. Rather, SC-CO<sub>2</sub> is a comprehensive damages metric that includes the value of future climate change impacts, including changes in net agricultural productivity, energy use, human health, property damage from increased flood risk, as well as nonmarket damages, such as the services from natural ecosystems to society. However, modeling limitations restrain the ability of the SC-CO<sub>2</sub> to capture all impacts of climate change. Despite recent improvements, it is likely that the SC-CO<sub>2</sub> still underestimates the full benefits of emissions reductions.

The staff analysis of the SC-CO2 for the Proposed Amendments uses the U.S. Environmental Protection Agency’s (U.S. EPA) new estimates of the social cost of greenhouse gases (U.S. EPA 2023a). These peer-reviewed estimates reflect recent advances in our understanding of climate change and its economic impacts and incorporate recommendations made by the National Academies of Science, Engineering, and Medicine. This approach is consistent with the approach presented in the U.S. EPA’s final Regulatory Impact Analysis of the Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review published in December 2023 and reflects the best available science in the estimation of the socioeconomic impacts of greenhouse gas emissions (U.S. EPA 2023b).

Previously, California’s regulatory assessments have presented the estimates of the SC-CO2 recommended by the Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases (SC-GHG) (US IA Working Group 2021). For example, this was the approach taken in the 2022 Scoping Plan Update. While U.S. EPA is a member of the IWG and participating in the IWG’s work under E.O. 13990, the IWG has not yet issued its updated approach. Therefore, this SRIA also presents the range of avoided SC-CO2 using the current IWG recommended values. Table 9 shows the range of SC-CO2 values used in the assessment.

Table 9: Values for the SC-CO2 (in 2022\$ per metric ton of CO2)

Emissions Year	EPA Values			IWG Values		
	2.5% discount rate	2% discount rate	1.5% discount rate	5% discount rate	3% discount rate	2.5% discount rate
2025	145	237	403	21	68	100
2030	161	257	430	23	73	107
2035	177	277	456	26	81	115
2040	194	299	482	31	88	123
2045	211	321	510	34	94	131
2050	229	345	539	38	101	139

The range of avoided SC-CO2 during 2025-2046 is the sum of the annual GHG emissions reductions from the increased Cap-and-Trade Program stringency and the GHG emissions reductions from increased GGRF expenditures in non-regulated sectors. In Table 10, staff analysis calculated the avoided SC-CO2 values by applying the values in Table 9 to the average emission reductions from the three Proposed Scenarios. Because differences in GHG emission reductions across the three Proposed Scenarios are small, Table 10 presents only the average of GHG emission reductions across the three scenarios. These benefits range from \$28 billion to \$460 billion, depending on the chosen discount rate and the source of the SC-CO2 estimates.



Table 10: Avoided Social Cost of Carbon Averaged Across the Proposed Scenarios (Billion 2022\$)

Year	GHG emission reductions (MMT)	EPA Values			IWG Values		
		2.5% discount rate	2% discount rate	1.5% discount rate	5% average	3% Avg	2.5% Avg
2026	10	\$2	\$3	\$4	\$0	\$1	\$1
2030	34	\$5	\$9	\$14	\$1	\$2	\$4
2034	52	\$9	\$14	\$23	\$1	\$4	\$6
2038	59	\$11	\$17	\$28	\$2	\$5	\$7
2042	58	\$12	\$18	\$29	\$2	\$5	\$7
2046	51	\$11	\$17	\$26	\$2	\$5	\$7
<b>Total</b>	<b>981</b>	<b>\$182</b>	<b>\$283</b>	<b>\$460</b>	<b>\$28</b>	<b>\$82</b>	<b>\$117</b>

### Health Benefits

The Proposed Amendments would reduce NOx and PM<sub>2.5</sub> emissions, resulting in health benefits in California. CARB staff analyzed the value of health benefits associated with 12 health outcomes, most of which were added or updated through CARB’s recent expansion to the scope of the health outcomes it assesses when evaluating regulatory programs (CARB 2022f): cardiopulmonary mortality, acute myocardial infarction, lung cancer incidence, asthma onset, asthma symptoms, hospitalizations for cardiovascular illness, hospitalizations for respiratory illness, hospitalizations for Alzheimer’s disease, hospitalizations for Parkinson’s disease, cardiovascular emergency department (ED) visits, respiratory ED visits, and work loss days.

These health outcomes have been identified by U.S. EPA as having a causal or likely causal relationship with exposure to PM<sub>2.5</sub> based on a substantial body of scientific evidence (U.S. EPA 2019, U.S. EPA 2021). U.S. EPA has determined that both long-term and short-term exposure to PM<sub>2.5</sub> plays a causal role in premature mortality, meaning that a substantial body of scientific evidence shows a relationship between PM<sub>2.5</sub> exposure and increased risk of death. This relationship persists when other risk factors, such as smoking rates, poverty, and other factors are taken into account. U.S. EPA has also determined a causal relationship between non-mortality cardiovascular effects (e.g., acute myocardial infarction) and short- and long-term exposure to PM<sub>2.5</sub>, a likely causal relationship between non-mortality respiratory effects (including worsening asthma) and short- and long-term PM<sub>2.5</sub> exposure, and a likely causal relationship between non-mortality neurological effects and long-term PM<sub>2.5</sub> exposure.

CARB staff analysis evaluated health impacts associated with reduced exposure to PM<sub>2.5</sub> and NOx emissions from the Proposed Amendments. NOx includes nitrogen dioxide, a potent lung irritant, which can aggravate lung diseases, such as asthma, when inhaled (U.S. EPA 2016). However, the most serious quantifiable impacts of NOx emissions occur through the conversion of NOx to fine ammonium nitrate aerosols through chemical processes in the atmosphere. PM<sub>2.5</sub> formed through such atmospheric transformations is termed secondary PM<sub>2.5</sub>. Both directly emitted PM<sub>2.5</sub> and secondary PM<sub>2.5</sub> are associated with adverse health outcomes. As a result, reductions in PM<sub>2.5</sub> and NOx emissions are associated with reductions in these adverse health outcomes.

To estimate the reductions in exposures to primary PM<sub>2.5</sub> emissions from sources different than on-road vehicles (which the incidence-per-ton methodology is based on), relative statewide potency factors were applied, derived from a CARB contract report that had evaluated exposures from multiple emissions sources in California (Apte et al. 2019). To account for differences in population exposures to a given amount of PM<sub>2.5</sub> emissions from stationary sources compared to on-road vehicle emissions, PM<sub>2.5</sub> emissions from agricultural, refining, industrial, and electricity generation sectors were multiplied by 0.38, 0.63, 0.43, and 0.23, respectively. Emissions from these stationary sources, which are released relatively further away from populated areas, are expected to result in lower overall health impacts than the same amount of emissions from motor vehicles on roadways that run through residential neighborhoods.

### *Incidence-Per-Ton Methodology*

CARB uses the incidence-per-ton (IPT) methodology to quantify the health benefits of emissions reductions in cases where dispersion modeling results are not available.<sup>27</sup> CARB's IPT methodology is based on a methodology developed by U.S. EPA (Fann et al. 2009, Fann et al. 2012, Fann et al. 2018, CARB 2022f).

Under the IPT methodology, it is assumed that changes in emissions are approximately proportional to changes in health outcomes. IPT factors are derived by calculating the number of health outcomes associated with exposure to PM<sub>2.5</sub> for a baseline scenario using measured ambient concentrations and dividing by the emissions of PM<sub>2.5</sub> or a precursor. The calculation is performed separately for each air basin using the following equation:

$$IPT = \frac{\text{number of health outcomes in air basin}}{\text{annual emissions in air basin}}$$

Multiplying the emissions reductions from the Proposed Amendments in an air basin by the IPT factor yields an estimate of the reduction in health outcomes achieved by the Proposed Amendments. For future years, the number of outcomes is adjusted to account for population growth. CARB's current IPT factors are based on a 2014-2016 baseline scenario, which represents the most recent data available at the time the current IPT factors were computed. IPT factors are computed for primary PM<sub>2.5</sub> and secondary ammonium nitrate PM<sub>2.5</sub> formed in the atmosphere from precursors.

### *Updated Information on Health Impact Analysis*

CARB recently expanded the scope of the health analyses it conducts for evaluating regulatory programs to include additional health endpoints in order to provide a more comprehensive analysis of the benefits associated with the agency's plans and regulations. A description of the updated and new health outcomes was provided in CARB's Updated Health Endpoints Bulletin, released November 2022 (CARB 2022f). This expansion in scope was based on U.S. EPA's Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS and is associated with U.S. EPA's Environmental

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<sup>27</sup> A description of this method is included on [CARB's Methodology for Estimating the Health Effects of Air Pollution](#) webpage.

Benefit Mapping and Analysis Program – Community Edition (BenMAP-CE) version 1.5.8 (U.S. EPA 2021).

To derive the IPT factor for each health endpoint, the number of health outcomes for each endpoint associated with exposure to PM<sub>2.5</sub> were calculated by inputting PM<sub>2.5</sub> concentrations from air monitoring data into U.S. EPA's BenMAP-CE version 1.5.8.4 (released April 16, 2021). The baseline incidence datasets embedded in the BenMAP-CE software were used; the incidence data for mortality, hospital admissions (including myocardial infarctions), and emergency department visits were provided at the county level, while the incidence data for work loss days was provided at the national rate in the software (U.S. EPA 2023c).

For most of the health endpoints, the U.S. EPA had identified one effect estimate derived from one study to be used in the respective health impact function. However, for myocardial infarction and respiratory ED visits, the U.S. EPA had identified multiple effect estimates; thus, U.S. EPA's health impact functions for these two endpoints were estimated using pooling methods. Pooling combines multiple risk estimates to determine a summary mean value estimate and associated confidence intervals (U.S. EPA 2021). For the myocardial infarction endpoint, the results were pooled from four different epidemiological studies using the random or fixed effects pooling and sum dependent pooling methods, as specified in the configuration file that U.S. EPA uses for PM quantification. For respiratory ED visits, the results were pooled using effect estimates derived from an analysis of four different U.S. locations in one study; this pooling also used the random or fixed effects method as specified in U.S. EPA's configuration file.

### *Reduction in Adverse Health Impacts*

CARB Staff analysis estimates that the total number of health endpoint cases statewide that would be reduced (from 2025 to 2046) from implementation of the Proposed Scenarios are as presented in Table 11.

Table 11: Projected statewide health benefits for the Proposed Amendments (increased Program stringency and GGRF expenditures in non-regulated sectors)

Health endpoint	Number of avoided cases from increased Program stringency	Number of avoided cases from increased GGRF expenditures	Toal number of avoided cases (Program stringency + GGRF expenditures)
Cardiopulmonary mortality	4,700 (2,600 – 6,700)	270 (150 – 390)	5,000 (2,740 – 7,080)
Cardiovascular disease	940 (680 – 1,190)	50 (35 – 60)	1,000 (720 – 1,250)
Cardiovascular ED visits	1,200 (-500 – 2,900)	65 (-25 – 150)	1,300 (-500 – 3,040)
Myocardial infarction	520 (190 – 1,390)	22 (8 – 58)	540 (200 – 1,450)
Respiratory disease	140 (5 – 270)	8 (0 – 15)	150 (5 – 285)
Respiratory ED visits	2,900 (560 – 5,980)	185 (35 – 385)	3,050 (60 – 6,370)
Lung cancer incidence	350 (110 – 570)	22 (7 – 37)	370 (115 – 600)
Asthma onset	11,100 (10,700 – 11,550)	680 (650 – 705)	11,800 (11,350 – 12,250)
Asthma symptoms	933,500 (-455,600 – 2,263,600)	57,400 (-27,900 – 139,400)	990,900 (-483,600 – 2,403,000)
Work loss days	675,000 (569,300 – 776,600)	41,400 (34,900 – 47,600)	716,300 (604,100 – 824,300)
Alzheimer’s disease	2,150 (1,650 – 2,610)	95 (70 – 120)	2,250 (1,720 – 2,730)
Parkinson’s disease	315 (165 – 455)	25 (13 – 37)	340 (180 – 490)

These reductions in adverse health cases are expected to be seen across all ages in the state. Children in particular will benefit from the reduced cases of asthma onset and symptoms due to the Proposed Amendments, which may lead to better health outcomes when these children become adults since studies have shown that childhood asthma puts individuals at greater risk for respiratory disease and lower respiratory function in adulthood (Sears et al. 2003, McGeachie et al. 2016). Adults are also expected to benefit from the Proposed Amendments due to fewer lost work days and fewer incidences of nonfatal acute myocardial infarctions (heart attacks), lung cancer, and cardiopulmonary mortality. Seniors may benefit from reduced cases of hospitalizations not only for cardiovascular and respiratory diseases, but also for neurological conditions (Alzheimer’s and Parkinson’s diseases). And there will be fewer ED visits for both cardiovascular and respiratory diseases across all ages in the population.

Table 12 shows the air basin distribution of avoided health endpoints for total emissions (increased Program stringency and increased GGRF expenditures in non-regulated sectors) under the Proposed Scenarios, relative to the Baseline Scenario during 2025-2046.

Table 12. Avoided Mortality and Morbidity Incidents<sup>28</sup> during 2025-2046 under the Proposed Amendments for total emissions (increased Program stringency + GGRF expenditures in non-regulated sectors)<sup>29</sup> by Air Basin<sup>30</sup>

Air basin	Cardio-pulmonary Mortality	Hosp. for Cardio-vascular Disease	Cardio-vascular ED Visits	Acute Myocardial Infarction	Hosp. for Resp. Disease	Resp. ED Visits	Lung Cancer Incidence	Asthma Onset	Asthma Symptoms	Work Loss Days	Hosp. for Alz. Disease	Hosp. for Park. Disease
GBV	10 (5-14)	1 (1-1)	2 (-1-5)	0 (0-1)	0 (0-0)	8 (2-20)	1 (0-1)	20 (20-21)	1,885 (-920-4,580)	1,335 (1,130-1,540)	4 (3-4)	1 (1-2)
LC	5 (3-7)	0 (0-1)	1 (0-3)	0 (0-0)	0 (0-0)	5 (1-10)	0 (0-1)	13 (12-13)	1,060 (-515-2,570)	655 (550-750)	1 (1-2)	0 (0-1)
LT	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	40 (-20-90)	25 (22-30)	0 (0-0)	0 (0-0)
MD	130 (70-190)	20 (15-30)	40 (-15-90)	15 (6-40)	3 (0-6)	75 (15-160)	8 (3-15)	280 (270-290)	23,730 (-11,560-57,635)	15,625 (13,170-17,990)	40 (30-50)	7 (3-10)
MC	90 (50-125)	15 (10-20)	20 (-7-40)	3 (1-10)	3 (0-6)	60 (10-120)	7 (2-10)	200 (190-210)	16,540 (-80,50-40,190)	13,000 (10,960-14,965)	40 (30-45)	10 (5-15)
NCC	75 (40-110)	15 (11-20)	20 (-10-45)	7 (2-20)	3 (0-5)	60 (10-130)	7 (2-10)	250 (240-260)	22,100 (-10,765-53,695)	14,320 (12,070-16,485)	25 (20-30)	7 (4-10)
NC	30 (20-45)	6 (4-7)	7 (-3-15)	2 (1-5)	1 (0-2)	20 (4-50)	2 (1-4)	65 (60-65)	5,250 (-2,555 - 12,760)	4,335 (3,650-4,990)	9 (7-12)	3 (1-4)
NP	5 (3-7)	1 (1-1)	1 (0-2)	0 (0-0)	0 (0-0)	4 (1-10)	0 (0-1)	10 (10-11)	835 (-405-2,030)	660 (555-760)	2 (1-2)	0 (0-1)
SV	210 (115-300)	40 (30-50)	50 (-20-120)	25 (10-70)	5 (0-10)	130 (25-270)	15 (5-25)	540 (515-560)	44,800 (-21,825-108,830)	31,600 (26,640-36,375)	55 (40-70)	15 (7-20)
SS	20 (10-25)	3 (2-4)	5 (-2-10)	2 (1-5)	1 (0-1)	15 (3-30)	1 (0-2)	50 (45-50)	3,990 (-1,945-9,690)	2,710 (2,290-3,120)	5 (4-6)	1 (1-2)
SD	100 (55-145)	25 (20-30)	30 (-10-65)	10 (4-30)	3 (0-6)	50 (10-110)	9 (3-15)	270 (260-280)	22,575 (-11,000-54,810)	17,080 (14,400-19,660)	75 (60-90)	8 (4-10)
SFB	600 (330-860)	160 (115-200)	160 (-60-380)	70 (30-200)	20 (1-40)	405 (90-840)	60 (20-100)	1,600 (1,540-1,665)	134,210 (-65,375-326,025)	105,700 (89,110-121,675)	345 (260-425)	65 (35-95)
SJV	1,165 (645-1,650)	180 (130-230)	300 (-120-710)	120 (45-325)	30 (1-60)	820 (160-1,700)	70 (20-115)	3,020 (2,905-3,130)	266,475 (-130,350-644,740)	162,045 (136,750-186,350)	400 (310-475)	55 (30-75)
SCC	75 (40-110)	15 (10-20)	20 (-10-40)	10 (3-20)	2 (0-5)	40 (10-80)	6 (2-10)	185 (180-190)	16,335 (-7,980-39,570)	11,330 (9,560-13,040)	30 (20-30)	6 (3-9)
SC	2,455 (1,355-3,500)	500 (370-640)	650 (-250-1510)	275 (100-730)	80 (3-150)	1,360 (270-2,835)	180 (60-290)	5,310 (5,100-5,510)	431,100 (-210,305-1,045,780)	335,910 (283,290-386,540)	1,220 (935-1,480)	165 (90-235)
State-wide	4,965 (2,740-7,080)	990 (720-1,250)	1,300 (-500-3,035)	545 (200-1,450)	150 (5-290)	3,060 (600-6,370)	370 (115-600)	11,810 (11,350-12,255)	990,910 (-483,570-2,403,005)	716,330 (604,150-824,260)	2,250 (1,720-2,730)	340 (180-490)

<sup>28</sup> Abbreviations used for mortality and morbidity incident categories are as follows: "Hosp." is "Hospitalizations"; "ED" is "Emergency Department"; "Resp." is "Respiratory"; "Alz." is "Alzheimer's"; "Park." is "Parkinson's."

<sup>29</sup> Numbers in parentheses throughout this table represent the 95% confidence interval.

<sup>30</sup> List of air basin names in full: Great Basin Valleys, Lake County, Lake Tahoe, Mojave Desert, Mountain Counties, North Central Coast, North Coast, Northeast Plateau, Sacramento Valley, Salton Sea, San Diego County, San Francisco Bay, San Joaquin Valley, South Central Coast, South Coast.

### *Uncertainties Associated with the Mortality and Illness Analysis*

Although the estimated health outcomes presented in this report are based on a well-established methodology, they are subject to uncertainty. Uncertainty is reflected in the 95% confidence intervals included with the central estimates in Table 12. These confidence intervals take into account uncertainties in translating air quality changes into health outcomes.

Other sources of uncertainty include the following:

- The relationship between changes in pollutant concentrations and changes in pollutant or precursor emissions is assumed to be proportional, although this is an approximation.
- Emission reductions are reported at a state level and do not capture local variations.
- Future population estimates are subject to increasing uncertainty as they are projected further into the future.
- Baseline incidence rates can experience year-to-year variation.
- The inherent uncertainty in the GHG emissions and energy modeling.

### *Potential Future Evaluation of Additional Health Benefits*

CARB recently expanded the scope of the health analyses it conducts for evaluating regulatory programs to include additional health outcomes in order to provide a more comprehensive review of the health impacts of air pollution exposure for this regulation and upcoming regulations.<sup>31</sup> However, note that the current mortality and morbidity evaluation conducted by CARB staff analysis still focuses on select air pollutants and only captures a portion of the health benefits of the Proposed Amendments. Further updates to the methodology may be made in the future to quantify additional benefits of reducing air pollution, such as by including additional pollutants and health outcomes. For instance, the current analysis considers the impact of NOx emissions on the formation of secondary PM<sub>2.5</sub>, but only includes a portion of the secondary PM<sub>2.5</sub>. In addition, NOx emissions can also react with other compounds in the atmosphere to form ozone, which can cause respiratory problems. Health benefits from reduced ozone exposure are not included in this analysis due to methodological limitations. Also, CARB will continue to evaluate approaches to provide both quantitative and qualitative information on health outcomes based on the best available science, such as through current literature reviews and CARB-funded research contracts.<sup>32</sup>

## **E. Monetization of Health Benefits**

The reductions in adverse health impacts described above can be assigned monetary values so the health benefits can be directly compared to other costs and savings associated with the Proposed Amendments. These values are derived from economics studies and are based on the expenses that an individual must bear for air pollution related health impacts, such as medical bills and lost work, or on willingness to pay metrics, which in addition to capturing the

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<sup>31</sup> More information can be found on [CARB's Methodology for Estimating the Health Effects of Air Pollution](#).

<sup>32</sup> More information on CARB's research contracts can be found on [CARB's online research page](#).

direct expenses of the health outcomes also capture the value that individuals place on pain and suffering, loss of satisfaction, and leisure time.

## Methodology

Health outcomes are monetized by multiplying each incident by a value per incident that is consistent with the IPT method described above, using the standard economic studies and data as provided in U.S. EPA's Environmental Benefit Mapping and Analysis Program – Community Edition (BenMAP-CE) (U.S. EPA 2023c).<sup>33</sup> The value per incident is derived from BenMAP-CE using the results for the total status quo PM-related incidence for each health endpoint used to derive the IPT and dividing them by the total valuation (or cost) as estimated in BenMAP-CE using the standard studies and data as listed in Table 13 to derive a dollar value for an avoided incident. These value per incident estimates are derived for each of the three years considered in our air quality scenario (2014-2016); an average is taken across the three years to derive the final estimate (CARB 2023g). The economic studies and data used are the same as those used in U.S. EPA's recent Revised Cross-State Air Pollution Rule Update (U.S. EPA 2021). The dollar values per incident therefore are equivalent to those evaluated in that rule, only varying due to California-specific economic and demographic data.<sup>34</sup>

The value per incident for each endpoint derived by the methods described above are shown in Table 13. The value for avoided premature mortality is based on the value of statistical life (VSL) (Science Advisory Board 2000), a measure of willingness-to-pay (WTP) from economic theory, which when applied to mortality risk provides a dollar estimate of benefits for an avoided premature death. The VSL is a statistical construct based on the aggregated dollar amount that a large group of people would be willing to pay for a reduction in their individual risks, such that one death would be avoided in the year across the population (CARB 2023g). Specifically, the U.S. EPA central estimate of \$7.4 million (2006\$) is used for VSL (U.S. EPA 2024). The estimate of VSL is adjusted for per capita income growth using U.S. EPA's central income elasticity estimate of 0.40 and the income growth forecast included in BenMAP-CE. This income elasticity estimate for VSL follows from empirical research and indicates that for every 1% increase in per capita income, the VSL increases by 0.4%, consistent with health risk reduction being a normal good whose demand increases with income. Finally, the value for VSL is adjusted for California inflation to present the values in 2022 dollars. While the economic benefit associated with premature mortality is important to account for in the analysis, the valuation of avoided premature mortality does not directly correspond to changes in expenditures and is therefore not included in the macroeconomic modeling.

Unlike mortality valuation, the cost savings for morbidity-related endpoints, such as avoided hospitalizations and emergency room visits, as well as avoided disease onset and occurrence, are based on the cost of illness (COI) methodology.<sup>35</sup> The COI methodology uses a combination of typical costs associated with hospitalization or disease occurrence to assign an

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<sup>33</sup> The BenMAP Tool can be found on the [BenMAP webpage](#).

<sup>34</sup> The California specific data that cause variation from national estimates are the data on county-level median daily wages and the age distribution of the population residing in each air basin. Small variations may also arise due to BenMAP-CE's Monte Carlo simulation methods.

<sup>35</sup> The WTP method is also used for valuation of one morbidity-related health endpoint: asthma symptoms.

economic value to avoidance of such outcomes. The types of cost that are included across the different valuation studies applied here include hospital charges, post-hospitalization medical care, out-of-pocket expenses, lost earnings for both individuals and family members, and lost household production (e.g., valuation of time-losses from inability to maintain the household or provide childcare).



Table 13: Valuation per Incident for Avoided Health Outcomes (2022\$)

Endpoint	Value Per Incident (2022\$)	Valuation Methodology	Notes
Premature Mortality	\$13,449,977	WTP	Shown at 2022 income levels. The estimate will grow annually proportional to income growth using U.S. EPA's central estimate for income elasticity of 0.40, and income growth forecast from BenMAP-CE.
<b>Hospitalizations and ER Visits</b>			
Hospitalizations for Parkinson's Disease	\$16,660	COI	Direct cost of hospitalization incident.
Hospitalizations for Respiratory Disease	\$12,683	COI	Direct cost of hospitalization incident.
Hospitalizations for Alzheimer's Disease	\$15,607	COI	Direct cost of hospitalization incident.
Hospitalizations for Cardio-, Cerebro-, and Peripheral Vascular Disease	\$20,070	COI	Direct cost of hospitalization incident.
ER visits, All Cardiac Outcomes	\$1,403	COI	Direct cost of ER visit.
ER visits, respiratory	\$1,506	COI	Direct cost of ER visit.
<b>Health Endpoint Onset/Occurrence</b>			
Incidence, Asthma	\$57,703	COI	Present value of lifetime healthcare cost and productivity losses using a 3% discount rate.
Asthma Symptoms, Albuterol use	\$272	WTP for symptoms + COI for Albuterol use	Willingness to pay plus cost of albuterol.
Incidence, Lung Cancer	\$32,609	COI	Direct medical cost of lung cancer. Cost discounted to present value at 3%.
Acute Myocardial Infarction, Nonfatal	\$79,201	COI	Present value of 3 years medical cost and earnings lost over a 5-year period. Using a 3% discount rate.
Work Loss Days	\$206	COI	Based on county-level median daily wages.

## Results

The statewide valuation of health benefits during 2025-2046 are displayed in Table 14, with the benefits disaggregated to separately show results from the increased Cap-and-Trade Program stringency and result from increased GGRF expenditures in non-regulated sectors. Table 15 shows the number of avoided adverse health outcomes on an annual basis and the associated valuation. The statewide valuation of health benefits during 2025-2046 is estimated to be \$73 billion, with approximately \$72 billion resulting from reduced premature cardiopulmonary mortality and \$1 billion resulting from reductions in other adverse health impacts. Of the total health benefits, \$3.9 billion is estimated to be a result of GHG emission reductions associated with increased GGRF expenditures. The spatial distribution of these benefits across the State follows the distribution of the health impacts by air basin as described in Table 12. These monetized benefits from all COI-based endpoint valuations are included in the macroeconomic modeling.

Table 14: Valuation of Statewide Health Benefits (million 2022\$)

Year	Benefits from Increased Cap-and-Trade Program Stringency	Benefits from Increased GGRF Expenditures in Non-Regulated Sectors	Total Statewide Health Benefits
2026	\$660	\$315	\$980
2030	\$2,565	\$235	\$2,800
2034	\$3,775	\$195	\$3,970
2038	\$4,060	\$130	\$4,190
2042	\$4,095	\$105	\$4,200
2046	\$3,215	\$45	\$3,260
<b>Total (\$ billion)</b>	<b>\$69.1</b>	<b>\$3.9</b>	<b>\$73.0</b>

Table 15: Avoided Incidents and Valuation of Statewide Health Benefits

Year	Cardiopulmonary Mortality	Hospitalizations for Parkinsons Disease	Respiratory ED Visits	Hospitalizations for Alzheimer's Disease	Hospitalizations for Cardiovascular Disease	Cardiovascular ED Visits	ER visits, respiratory	Asthma Onset	Asthma Symptoms	Lung Cancer Incidence	Acute Myocardial Infarction	Work Loss Days	Valuation (Million 2022\$)
2026	70	5	2	27	12	19	47	191	17,570	5	7	10,790	\$980
2030	197	13	6	85	38	53	126	500	43,920	15	22	29,350	\$2,800
2034	274	19	8	124	54	73	171	661	53,730	20	30	40,120	\$3,970
2038	284	20	9	133	58	74	173	665	54,380	21	31	40,720	\$4,190
2042	279	19	8	128	57	72	168	637	53,270	21	30	39,180	\$4,200
2046	212	15	7	102	45	54	123	461	38,340	16	23	29,160	\$3,260
<b>Total</b>	<b>4,960</b>	<b>342</b>	<b>149</b>	<b>2,250</b>	<b>989</b>	<b>1,300</b>	<b>3,060</b>	<b>11,810</b>	<b>990,910</b>	<b>369</b>	<b>544</b>	<b>716,330</b>	<b>\$73,000</b>

## Other Benefits

Additional benefits to individuals from the Proposed Amendments may include the following:

- California’s path to decarbonization will provide new jobs and economic opportunities in clean-energy industries.
- A well-designed Cap-and-Trade Program that continues to reduce GHG emissions while growing the economy signals the viability of the Program and supports other jurisdictions in pursuing similar policies. CARB’s policy leadership may have profound effects on the global effort to combat climate change, which in turn benefits California by further reducing the risk of prolonged drought, heat waves, wildfires, and other extreme weather-related events.

## F. Equity Considerations

In authorizing a market-based compliance mechanisms such as the Cap-and-Trade Program for achieving California’s GHG reduction goals, AB 32 requires CARB to “consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution,” and to “ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.”<sup>36</sup>

While the Program is designed to achieve statewide GHG emissions reduction targets, the distribution of costs and benefits of the Program may vary within the State and lead to different impacts on different populations. For example, the use of GGRF revenues is targeted to deliver greater benefits to priority populations and expand access to clean energy technologies in communities that may otherwise lack the financial resources to transition away from fossil fuels and accrue the associated benefits. The Program also directly impacts community-level pollution exposure by penalizing fossil fuel combustion at covered facilities, which releases harmful criteria pollutants.

As the Program has evolved, some stakeholders have questioned whether the flexibility of compliance mechanisms, such as allowance banking, compliance offset credits, and secondary market transfers has concentrated, rather than reduced, criteria pollutant emissions from large covered facilities located in vulnerable communities. However, external researchers have examined this question and have generally found that, across facilities and the timeline of implementation, the opposite effect has occurred. For example, a 2022 study from Hernandez-Cortes and Meng (Hernandez-Cortes and Meng 2022) examined GHG and air pollution data from 2008 through 2017 and found that, since the Cap-and-Trade Program took effect, air quality in disadvantaged communities<sup>37</sup> improved more than air quality in wealthier, less polluted neighborhoods, although disparities still persist. Additionally, a 2022 report by the Office of Environmental Health and Hazard Assessment (OEHHA) found that, through 2017,

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<sup>36</sup> Sections 38570(b)(1) and 38562(b)(2), respectively of the California Health and Safety Code

<sup>37</sup> Specifically, zip codes containing all or part of a California census tract that scores in the top 25% of average pollution and socioeconomic indicators in CalEnviroScreen v1.1 (the version containing pre-Cap-and-Trade pollution data). The definition of “disadvantaged community” is the same one used to inform the targeted investment of GGRF revenues, per SB 535.

the greatest beneficiaries of reduced emissions from facilities subject to the Cap-and-Trade Program have been disadvantaged communities and communities of color in California (OEHHA 2022). The results of both of these studies reflect the geographic distribution of large, covered facilities, which are disproportionately located in or near disadvantaged communities and produce significant amounts of air pollution through the on-site combustion of fossil fuels. The OEHHA report also emphasizes that the relationship between GHGs and co-pollutants was highly variable by year and by sector, and that a wide pollution gap still remains. Looking forward, researchers have also noted that further increases in Program stringency will likely produce further improvements in local air quality; to quote Cushing et al. (2016), “as regulated industries adapt to future reductions in the emissions cap, California is likely to see more reductions in localized GHG and co-pollutant emissions.”

The Cap-and-Trade Program was designed to cost-effectively reduce statewide GHG emissions and was not developed to address the criteria pollutant emissions that cause health impacts. The authority to address criteria pollutant emissions from stationary sources largely rests with local air districts, which oversee local permitting and air pollutant regulations in support of meeting State and Federal Clean Air Act standards. However, by imparting an economy-wide price on the combustion of fossil fuels, the Program disincentivizes fossil fuel combustion at covered facilities, which disproportionately benefits the communities in which they are located. The Program also directly benefits these communities through targeted GGRF expenditures of allowance auction revenues. As mentioned, GGRF revenues are largely directed toward projects that directly benefit priority populations, and utility revenues provide additional benefits through ongoing investments in community solar projects, other clean energy projects, and the California Climate Credit.<sup>38</sup> The California Climate Credit, which is a direct cash transfer to utility ratepayers, is a critical tool to offset some of the Program’s impact on residential energy prices and especially benefits low-income ratepayers who spend a higher portion of their income on utility bills. The Proposed Amendments are expected to increase revenues available for all these programs and will also directly increase utility revenues used to benefit low-income ratepayers.

In short, the Cap-and-Trade Program benefits priority populations more than other parts of the State.<sup>39</sup> By increasing the stringency of the Program, the Proposed Amendments are expected to reduce emissions, increase revenues, and provide more equitable outcomes for the communities most impacted by environmental pollution.

### **III. Direct Costs**

#### **A. Direct Cost Inputs**

Direct costs of the Proposed Amendments represent the incremental difference in expected compliance costs and GHG abatement costs relative to the Baseline Scenario. Under the Proposed Scenarios, CARB proposes to remove 264 million allowances from current 2025-2030 Program budgets and include post-2030 allowance budgets that decline linearly to reach

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<sup>38</sup> More information can be found on [CPUC’s webpage on California’s Greenhouse Gas Cap-and-Trade Program](#).

<sup>39</sup> More information can be found on [CARB’s Cap-and-Trade Program FAQ webpage on Environmental Justice Communities and Local Air Pollution](#).

an 85% GHG emissions reduction by 2045. The cumulative GHG emissions reductions associated with these allowance removals reflect a 48% GHG reduction relative to 1990 levels by 2030 and an 85% reduction by 2045. Each metric ton of GHG emissions reductions also corresponds to a metric ton of abatement in sectors covered by the Cap-and-Trade Program, which produces additional direct economic costs that are attributable to the more stringent Cap-and-Trade Regulation.

### **Cap-and-Trade Program Compliance Costs**

The most influential variables driving the compliance cost difference among the Proposed Scenarios and the Baseline Scenario are covered emissions and allowance prices. Embedded in the Proposed Scenarios is also an expectation that complementary policies will work as designed. We know factors such as supply chain issues and legal challenges to other policies could potentially increase demand for allowances under the Cap-and-Trade Program moving forward. By establishing a range of costs between the auction floor and price ceiling, staff analysis captures the range of costs that may materialize under a wide variety of scenarios where external factors, such as macroeconomic conditions and outcomes of complementary policies, may require Program flexibility. Future allowance prices are highly uncertain, and staff are unable to specifically predict the extent or timeframe of any allowance price increases due to increased Program stringency and uncertainty in performance of complementary policies. In the absence of more granular allowance price projections, staff analysis assumes that average allowance prices during 2025-46 will fall half-way between the price floor and the APCR Tier 1 price. The price floor is a reasonable lower bound on prices, and the APCR Tier 1 price is a reasonable upper bound since projected allowance demand under the Proposed Scenarios does not exhaust the non-APCR allowances, implying that APCR allowances are also not exhausted and that prices remain below the APCR Tier 1 price. Using a weighted average price that reflects the proportion of total auctioned allowances sold at auction in a given year during 2025-2046, staff analysis assumes under the Proposed Scenarios that allowances will be sold at auction for an average price of \$60 (versus \$39 in the baseline).

Allowance prices are largely a function of allowance demand, and other Cap-and-Trade Program models may show differing allowance prices due to different demand assumptions and different modeled end years. To support developing the Proposed Amendments, CARB staff contracted with a research team at UC Davis to model expected allowance prices given a range of allowance budget options (CARB MELCCFP 2023). The draft modeling results indicate that if emissions trajectories are constant between scenarios, more limited allowance budgets will tend to push allowance prices upward. The modeling also indicates that results are strongly influenced by the end year, with likely lower prices and more surplus allowances when the Program was modeled to end in 2030 and potentially higher prices and a potential longer-term tighter supply of allowances in modeling results for 2040 (CARB MELCCFP 2023). It is important to note that the UC Davis modeling provides an average value from of a distribution of model outcomes and does not represent a single estimate of the potential price in any year, it reflects the model assumption that the expected long-term allowance supply and demand balance is immediately and perfectly reflected in near-term market behavior prices, and does not necessarily reflect expected prices in the real-world market which are influenced by complex behavior of market participants. Independent modeling by the Québec Ministry of Finance for the Québec Ministry of the Environment, which oversees the linked Québec Cap-and-Trade System, shows a similar dynamic, albeit with lower allowance price results (CARB

MELCCFP 2023). The UC Davis and MELCCFP models have some differences in approach, input assumptions, and sources of uncertainty. Taken together, the results of these two modeling efforts aid understanding of the trajectory of potential impacts of the Proposed Amendments and comparison between evaluated scenarios. Building on those analyses, CARB staff similarly assume that the more stringent scenarios produce higher average allowance prices, but prices for each scenario are lower than in the UC Davis and Québec Ministry of Finance modeling exercises due to different assumptions about future emissions (i.e., allowance demand). Specifically, staff analysis suggests that, as GHG emissions fall in response to California's suite of climate change programs, cumulative allowance demand through 2045 may not exhaust cumulative Program budgets and thus average allowance prices may find a middle ground between the auction price floor and the price ceiling. It is important to recall there is an inherent assumption that all complementary policies deliver GHG reductions as expected. Changes in the performance of those policies will impact demand for the sectors covered by the Program.

In addition to updated future allowance budgets, staff analysis also incorporates the following changes to the Regulation, as described in the Description and Statement of Need for the Proposed Amendments:

- Updated 2025-2030 EDU allowance allocation, post-2030 EDU allowance allocation, and POU consignment requirements. Under the Proposed Amendments, EDUs will receive fewer total free allowances, and POUs will need to consign these allowances to auction rather than depositing them directly for compliance. These changes may increase direct compliance costs for EDUs relative to the Baseline Scenario, though increased consignment and allowance prices will lead to an increase in total EDU allowance auction revenues available for ratepayer benefit (primarily the California Climate Credit).
- Projected future industrial allowance allocation and new incentive allocation for industrial decarbonization. Some sectors will benefit from incentive allocation for industrial decarbonization. Other sectors may see a decrease in total allowance allocation, since industrial allocation decreases annually in proportion to the overall Program caps.
- Depositing approximately 5.5 million additional 2025-2030 Program allowances into the VRE Reserve account. This change will produce a small indirect cost increase on all covered entities, since VRE allowances are removed from the general pool of state-owned allowances that would otherwise be auctioned and available for compliance. However, the availability of VRE allowances directly benefits entities that wish to formally recognize voluntary procurement of renewable electricity in excess of State RPS requirements.

As described in the Introduction, CARB is also considering whether the proposed allowance removals will be drawn from general allowance budgets for auction and allocation or the APCR, or some combination thereof. Staff's assessment of the Proposed Scenarios (A, B, and C) shows that the source of allowance removals has a minor impact on compliance

costs,<sup>40</sup> as cumulative covered emissions (i.e., allowance demand) may not exhaust the non-APCR allowances. However, if real world emissions are higher than these projections, then the source of allowance removals may further affect compliance costs by altering the price at which allowances are sold at auction. This analysis does not provide insight into how the differences in removal of allowances from the auction and allowance pool could result in minor impacts on compliance costs for the Program overall, but could potentially change the leakage potential for covered sectors.

Finally, projected covered emissions for each covered entity will also impact MRR reporting and verification costs, though MRR cost differences in the Proposed Scenarios are minor relative to differences in the costs of purchasing allowances. Under MRR, entities emitting more than 10,000 MTCO<sub>2</sub>e annually must report GHG emissions to CARB, and entities exceeding the 25,000 MTCO<sub>2</sub>e per year threshold must have their GHG emissions reports verified by an accredited third party. Prior staff analyses for MRR demonstrate typical reporting costs of around \$1,100 per year and verification costs of \$7,000 per year (CARB 2012). Combined across all current Cap-and-Trade Program covered entities during 2025-2046, total MRR cost savings from some covered entities dropping below the reporting and verification thresholds total \$6.3 million, or \$240,000 per year.

### **GHG Emissions Abatement Costs**

Under the Proposed Scenarios, a more constrained allowance supply pushes average allowance prices higher, incentivizing the adoption of more expensive abatement measures in sectors covered by the Program. Different sectors have different heating needs and different economic and technical constraints, and thus may follow differing abatement paths. There may also be other and less expensive actions unique to a sector or facility, that could be pursued beyond the key options provided in Table 16.

Though abatement of industrial emissions relies on fuels and technologies with uncertain future costs, staff analysis evaluated a range of broadly applicable potential abatement options and associated costs for covered industrial sectors to produce a reasonable estimate of what GHG emissions reductions from California's industrial facilities may cost during 2025-2046. Staff analysis differentiates capital costs from ongoing operating costs (mainly due to changing fuel type) and incorporates a 5% discount rate for calculating the net-present-value of capital expenditures over an assumed 30-year equipment lifetime.

Staff analysis used a natural gas rate of \$12/MMBtu based on the EIA Annual Energy Outlook (EIA 2021) and scaling the U.S. average rate to California rates (EIA 2024).<sup>41</sup> Staff analysis used an electricity price of 20 cents/kWh based on electricity rate forecasts by the California Energy Commission (CEC) (Marshall 2023). The GHG reduction cost assumptions for industrial sectors are shown in Table 16.

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<sup>40</sup> Specifically, the source of allowance removals affects Cap Adjustment Factors, which impacts industrial and natural gas allocation and thus affects covered entity net allowance demand.

<sup>41</sup> Staff analysis shows 2020-2021 California rates were on average 2.33 times larger than the Annual Energy Outlook US average industrial price.

Table 16: GHG Reduction Costs for Key Technologies with Applications in California’s Industrial Sectors

Technology	GHG Reduction Cost [Range] (\$/MTCO <sub>2e</sub> )	Applicable Industries
Renewable Natural Gas	\$245 [-94 – 622]	All sectors using natural gas
Carbon Capture and Storage <sup>42</sup>	\$73 [48 – 100]	All sectors
High Temperature Heat Pumps	\$135 [-5 – 316]	Food processing, paper production, sectors using boilers
Concentrated Solar Thermal	\$352 [187 – 595]	Food processing, oil and gas extraction, mining
Hydrogen	\$404 [309 – 502]	All sectors
Electrification	\$399 [190 – 752]	All sectors

In total, the adoption of the technologies listed in Table 16 is estimated incur approximately \$2.9 billion per year in abatement costs for industrial sectors, which represents a production cost increase of \$2.2 billion annually above the Baseline Scenario.

Electricity sector abatement decisions are also driven by Cap-and-Trade Program carbon pricing on fossil fuel generation. Electricity sector abatement costs are included in this analysis and do vary among scenarios due to the timing of deployment and differences in utility allowance revenues available to assist with abatement costs.

Finally, staff analysis includes abatement costs associated with lowering the carbon intensity of fuel use in residential and commercial buildings. The Program carbon price on fossil fuels helps induce increased use of fuel substitutes, such as renewable natural gas, low-carbon hydrogen, or renewable diesel (e.g., in backup electricity generators). The costs of these fuel substitutions are assumed to accrue in proportion to the amount of fuel substitution included in 2022 Scoping Plan Update emissions modeling. These building sector abatement costs are also modeled as being passed through to consumers in retail natural gas rates, which are subject to CPUC oversight and may be mitigated by the California Climate Credit.

Staff analysis only includes abatement costs for key decarbonization measures that are attributable to increased stringency of the Cap-and-Trade Regulation.

### Total Costs

Total costs attributable to the Proposed Amendments are the sum of Program compliance costs and GHG emissions abatement costs across covered entities during 2025-2046, relative to status quo Program implementation. Table 17 shows the increase in annual total costs for the Proposed Amendments, relative to the Baseline Scenario, for sectors covered by the Cap-and-Trade Program. Figure 5 shows statewide costs relative to California gross state product.

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<sup>42</sup> Cost analysis includes CCS for petroleum refineries, however the amount of CCS deployed does not vary between scenarios and thus does not influence any total cost differences.



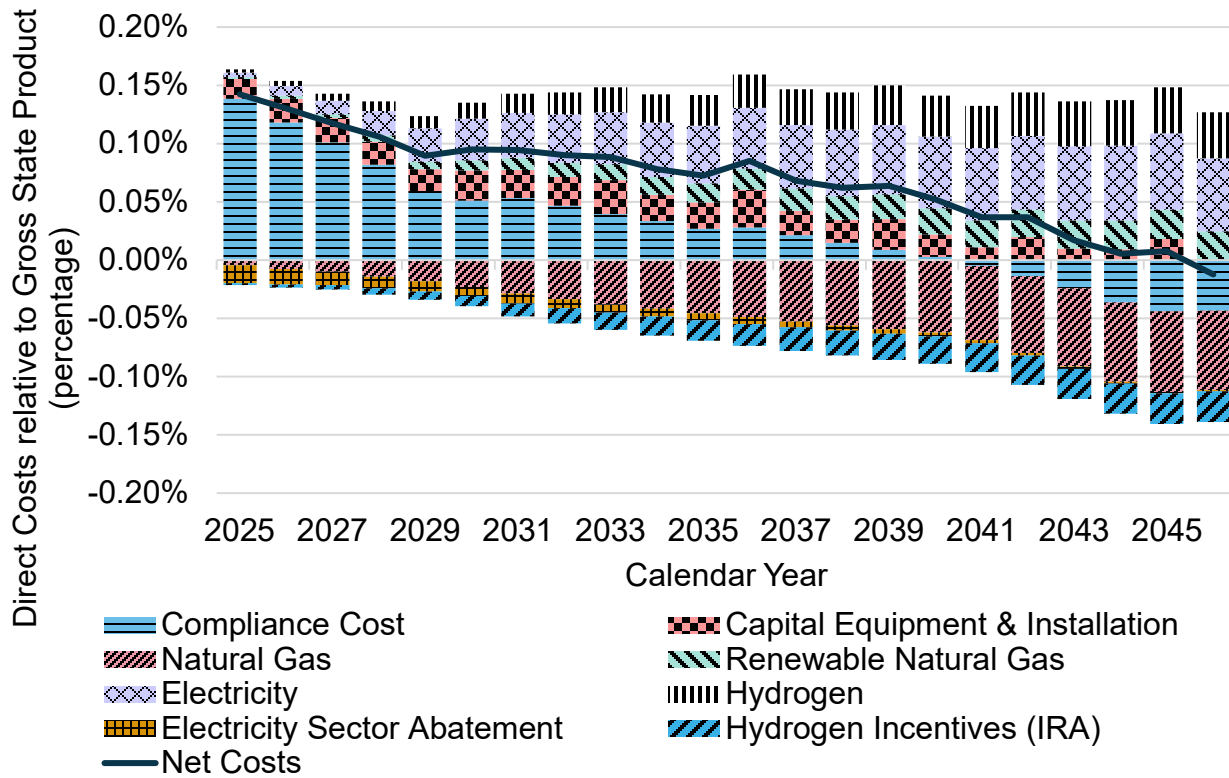
Table 17. Total Statewide Costs of Proposed Scenario B, Relative to the Baseline from 2025-2046 (\$ million)

Year	Energy Sectors (Electricity, Natural Gas, Transportation Fuels)		Industrial Sectors (Manufacturing, Oil & Gas Production, Refineries)		Energy Cost Savings <sup>43</sup> (All Sectors)	Hydrogen Incentives (IRA) <sup>44</sup>	Total Costs	Total Cost-Savings	Net Costs
	Program Compliance	Abatement Attributed to the Program	Program Compliance	Abatement Attributed to the Program					
2025	\$5,530	\$975	-\$1,155	\$745	-\$970	-\$20	\$7,250	-\$2,145	\$5,105
2026	\$4,930	\$950	-\$1,120	\$1,060	-\$965	-\$40	\$6,940	-\$2,125	\$4,815
2027	\$4,400	\$930	-\$1,080	\$1,270	-\$965	-\$60	\$6,600	-\$2,105	\$4,495
2028	\$3,935	\$775	-\$1,035	\$1,535	-\$1,040	-\$105	\$6,245	-\$2,180	\$4,065
2029	\$3,525	\$360	-\$985	\$1,820	-\$1,110	-\$145	\$5,705	-\$2,240	\$3,465
2030	\$3,170	\$450	-\$930	\$2,480	-\$1,215	-\$185	\$6,100	-\$2,330	\$3,770
2031	\$2,995	\$760	-\$905	\$2,670	-\$1,300	-\$210	\$6,425	-\$2,415	\$4,010
2032	\$2,735	\$835	-\$885	\$2,960	-\$1,375	-\$235	\$6,530	-\$2,495	\$4,035
2033	\$2,470	\$890	-\$865	\$3,405	-\$1,465	-\$255	\$6,765	-\$2,585	\$4,180
2034	\$2,205	\$970	-\$845	\$3,395	-\$1,535	-\$280	\$6,570	-\$2,660	\$3,910
2035	\$1,940	\$1,030	-\$825	\$3,625	-\$1,605	-\$300	\$6,595	-\$2,730	\$3,865
2036	\$1,675	\$1,390	-\$805	\$4,360	-\$1,705	-\$325	\$7,425	-\$2,835	\$4,590
2037	\$1,410	\$1,460	-\$785	\$4,065	-\$1,770	-\$350	\$6,935	-\$2,905	\$4,030
2038	\$1,145	\$1,515	-\$760	\$4,225	-\$1,830	-\$370	\$6,885	-\$2,960	\$3,925
2039	\$880	\$1,550	-\$740	\$4,790	-\$1,920	-\$390	\$7,220	-\$3,050	\$4,170
2040	\$615	\$1,630	-\$720	\$4,645	-\$1,975	-\$410	\$6,890	-\$3,105	\$3,785
2041	\$350	\$1,660	-\$700	\$4,300	-\$1,995	-\$425	\$6,310	-\$3,120	\$3,190
2042	\$85	\$1,675	-\$680	\$4,725	-\$2,050	-\$440	\$6,485	-\$3,170	\$3,315
2043	-\$175	\$1,710	-\$660	\$4,110	-\$2,065	-\$455	\$5,820	-\$3,355	\$2,465
2044	-\$440	\$1,725	-\$640	\$3,865	-\$2,075	-\$465	\$5,590	-\$3,620	\$1,970
2045	-\$705	\$1,855	-\$620	\$4,235	-\$2,130	-\$480	\$6,090	-\$3,935	\$2,155
2046	-\$705	\$1,900	-\$620	\$3,230	-\$2,110	-\$475	\$5,130	-\$3,910	\$1,220
<b>Total (\$ billion)</b>	<b>\$42.0</b>	<b>\$27.0</b>	<b>-\$18.4</b>	<b>\$71.5</b>	<b>-\$35.2</b>	<b>-\$6.4</b>	<b>\$142.5</b>	<b>-\$62.0</b>	<b>\$80.5</b>

<sup>43</sup> Energy cost savings include the monetary value of avoided natural gas consumption and additional utility allowance revenues that are directed toward production or procurement of renewable electricity.

<sup>44</sup> The federal Inflation Reduction Act (IRA) offers a low-carbon hydrogen tax credit of up to \$3 per kilogram (Congressional Research Service 2022).

Figure 5. Statewide Costs of Proposed Scenario B



### Cost-Effectiveness

To summarize the cost and benefits of the Proposed Scenarios, both the total costs and total benefits are presented in Table 18. Cost-effectiveness is a measure of the cost of a regulation per ton of expected emissions reduction. There are multiple approaches to calculating cost-effectiveness. For the Proposed Scenarios, staff analysis calculated the cost-effectiveness by dividing the net direct cost of the regulation from 2025 to 2046 by the expected emissions reductions over that time-period.

As shown in Table 18, the total costs of the Proposed Scenarios are \$143 billion; less transfers to governments and individuals, the net direct cost is \$122 billion. The total cost-savings plus health benefits is \$135 billion, representing the subset of quantifiable benefits to California. The social cost of carbon is a global benefit and is also evaluated as part of the summary measures in Table 18. The net direct benefits of the Proposed Scenarios total \$13 billion from 2025 through 2046.

Table 18. Summary of Cost, Benefits, and Cost-Effectiveness of the Proposed Scenarios

<b>Benefit and Cost Measures</b>	<b>Proposed Scenarios (Billion 2022\$)</b>
<b>Total Costs less Transfers</b>	<b>121.9</b>
Total Costs	142.5
Transfers <sup>45</sup>	20.6
<b>Total Benefits</b>	<b>135</b>
Total Costs-Savings	62.0
Health Benefits	73.0
<b>Summary with Social Cost of Carbon</b>	
Social Cost of Carbon	28 - 460
Net-Benefit	41.0 – 473.0
<b>Cost-Effectiveness</b>	
GHG Emission Reductions (MMTCO <sub>2</sub> e)	981.0
GHG Cost-Effectiveness (\$/MTCO <sub>2</sub> e)	61

## **B. Direct Costs on Typical Businesses**

Based on projected covered emissions for 2025 under the Proposed Scenarios, the Cap-and-Trade Program covers approximately 350 covered facilities across many different sectors. Cap-and-Trade Program covered entities face a wide range of potential compliance costs and abatement options during 2025-2046. Differences in compliance costs are driven by several factors, such as differences in allowance allocation, abatement options, and difference in the scope and emissions intensity of their operations. Covered facilities may reduce Program compliance costs by investing in GHG emissions abatement technologies, and different sectors have different costs and feasibility for abatement. Table 19 shows the anticipated covered emissions obligation and the associated increase in total Program costs during 2025-2046 (key abatement cost assumptions are discussed above in the section on GHG Emissions Abatement Costs). Both compliance costs and abatement costs are considered an increase in production costs that may be passed down to consumers.

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<sup>45</sup> Includes utility allowance revenues used for ratepayer benefit, GGRF revenues for which no emission benefits are attributed to the Proposed Scenarios, and tax and fee revenue.

Table 19: Proposed Scenarios Projected Covered Emissions and Costs by Sector

Two-Digit NAICS and Description	Number of Covered Facilities	2025-46 Projected Emissions Obligation (million MTCO <sub>2e</sub> )	2025-46 Increase in Program Compliance Costs (\$ million)	2025-46 Increase in Abatement Costs (\$ million)	2025-46 Increase in Total Costs (\$ million)	Average Annual Increase in Total Costs (\$ million)
21 - Mining, Quarrying, and Oil and Gas Extraction	32	164	\$300	\$4,510	\$4,805	\$5
22 - Utilities	156	1,151	\$23,270	\$9,550	\$32,820	\$10
31-33 - Manufacturing	95	393	(\$18,460)	\$42,550	\$24,085	\$25
42 - Wholesale Trade	33	989	\$17,130	\$165	\$17,295	\$25
44-45 - Retail Trade	7	56	\$965	(\$0)	\$965	\$15
48-49 - Transportation and Warehousing	8	12	\$160	\$70	\$230	\$1
52 - Finance and Insurance	4	5	\$85	(\$40)	\$50	\$0.6
61 - Educational Services	10	11	\$155	(\$95)	\$55	\$0.3
Other Sectors (11, 54, 55, 56, 62)	8	5.8	\$17	\$147	\$164	\$0.9
<b>Total</b>	<b>353</b>	<b>2,785</b>	<b>\$23,600</b>	<b>\$56,900</b>	<b>\$80,500</b>	<b>\$10</b>

## C. Direct Costs on Small Businesses

Due to the 25,000 MTCO<sub>2</sub>e/year covered emissions threshold for incurring a Cap-and-Trade Program compliance obligation, small businesses typically do not face any direct costs associated with the Regulation. However, small businesses may be indirectly affected by any increased carbon costs from the Program that covered entities pass through to consumers. Costs will vary based on the businesses' use of fossil fuels and ability to reduce the use of fossil fuels in their operations.

## D. Direct Costs on Individuals

While individuals do not face direct Cap-and-Trade Program compliance costs, the Proposed Amendments may impart an increased carbon price signal in consumer energy prices and in the price of goods produced in-state. The indirect carbon costs passed through to individuals accrues volumetrically, such that individuals with greater energy or product consumption would face a higher total cost associated with the Program. Staff analysis assessed the potential cost pass-through to individuals from increased stringency of the Proposed Amendments, and the results of this assessment are included in Table 20. These cost increases are expected to result in some changes to consumer behavior. Since the Cap-and-Trade Program is an economy-wide Program covering roughly 80% of total statewide GHG emissions from non-NWL sources, the staff analysis assumes full cost pass-through to consumers, and Table 20 expresses all cost increases under the Proposed Scenarios on a per-capita basis. Table 20 also compares these costs to additional benefits that may accrue to individuals as a result of increased Program stringency, though impacts to specific individuals vary widely based on geography, consumption patterns, and the distribution of GGRF funds and utility allocated allowance auction proceeds. See Section II.D. for more information about the benefit categories included in Table 20.

Importantly, retail fossil fuel prices are strongly influenced by many factors beyond any allowance price (e.g., global events, holiday weekends, seasonal fluctuations, refinery disruptions and decisions about production that affect supply, refinery pricing decisions, seasonal fuel blends, taxes) and fossil fuel producer pricing strategies are complex and reflect local and regional market conditions. Few of these factors are determined by government entities, including the State of California. Between 2017 and 2022, the retail price of gasoline fell as low as \$3.08 and rose as high as \$5.41, and similarly for diesel, the retail price ranged between \$3.07 and \$6.02.<sup>46</sup> Retail gas prices in California aren't fully explained by the current regulatory environment and are being evaluated further per direction from Governor Newsom.<sup>47</sup> Predicting how allowance price changes impact these complex pricing strategies and the per gallon gasoline and diesel prices paid at the pump in the future by consumers is beyond the scope of this work. Similarly, if vehicle efficiency improves significantly under federal fuel economy standards, consumers of fossil fuels can travel much further on the same gallon of gasoline and diesel. Therefore, total household expenditure on fossil fuel may not rise

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<sup>46</sup> See United States Energy Information Administration, [Annual Retail Gasoline and Diesel Prices](#) for more information.

<sup>47</sup> [Governor Newsom's Gas Price Gouging Proposal Gains Momentum, Clears Senate | California Governor](#)

as much as a result of California’s suite of GHG policies, even if the price per gallon of those fossil fuels increases due to the Proposed Amendments.

Table 20: Estimated Annual Impact to Individuals Under the Proposed Scenarios (2025-2046)

<b>Cost or Benefit Category (Proposed Scenarios, Relative to Baseline)</b>	<b>Total Value, Annualized (\$ million)</b>	<b>Per-Capita Value,<sup>48</sup> Annualized (\$)</b>
Net Economy-Wide Costs	-\$3,660	-\$90 <i>(assuming full cost passthrough)</i>
Benefit from GGRF Revenues	\$440	\$10
Benefit from Utility Revenues for California Climate Credit	\$270	\$7
Monetized Health Benefits	\$3,320	\$80

**E. Equity Considerations**

As an economy-wide program, the Cap-and-Trade Program imparts a wide range of cost impacts on individuals and businesses by incorporating a carbon price into the price of energy and goods. Staff is putting forth Proposed Amendments that aim to meet the urgency of the climate crisis and accelerate California’s transition to a carbon-neutral economy, but in doing so must ensure that the costs of this transition do not fall disproportionately on vulnerable and overburdened populations. Staff recognize that the financial impact of increasing fuel prices is felt more acutely by low-income households that spend a greater percentage of their income on energy costs. In addition, due to persisting health and opportunity gaps, not all communities are equally resilient in the face of climate impacts. Staff further recognize that the harms of climate change will likely fall disproportionately on vulnerable populations that already live in areas of the State more prone to extreme weather and lack the financial means to adapt. Figure 6 shows the Climate Vulnerability Metric (CVM), which is a tool focused on the community-level impacts of a warming climate on human welfare, at the census tract level under a moderate emissions scenario (CARB 2022g). The CVM shows that climate change will have highly unequal impacts across California.

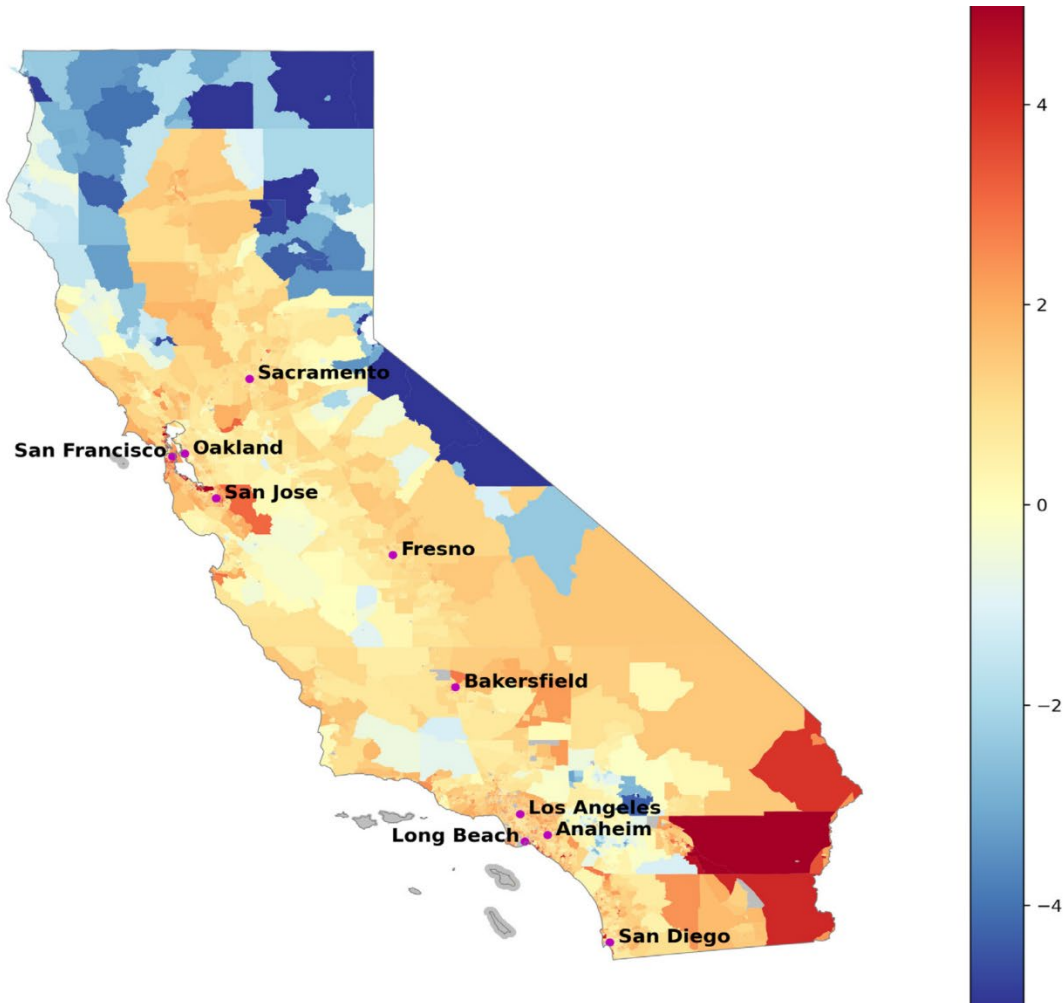
As discussed in the Analysis of Benefits, the Program includes mechanisms to help alleviate this burden including targeted use of GGRF expenditures and the California Climate Credit to ease the transition to low-carbon alternatives for and household energy needs. In addition to reductions achieved as the transportation sector transitions to zero emissions technology, staff analysis assumes that the Proposed Amendments will reduce the combustion of fossil fuels at covered stationary sources, many of which are located in low-income communities that also face the highest levels of air pollution in the State from both mobile and stationary sources. Thus, while the Program is designed to reduce statewide greenhouse gas emissions, the

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<sup>48</sup> Based on an average California population of 39,762,098 from 2025-2046, following the demographic forecast described in Section V.A.

greatest co-benefits of decreased air pollution emissions owing to facility-level abatement measures are expected to accrue to the communities currently most impacted by air pollution (OEHHA 2022).

Figure 6. Combined impacts of climate change in 2050 under a moderate emissions scenario; damages as share of 2019 tract income (%)



The map shows combined impacts of climate change in 2050 under a moderate emissions scenario (RCP 4.5), reported as a share of 2019 census tract income. For example, a CVM value of 3 implies that by 2050, a census tract is projected to experience human welfare impacts of climate change that amount to 3% of annual income. Impacts are combined across the categories shown in Figure 3-9. The higher the CVM for a given census tract, the more damaging the projected impacts of climate change on human welfare. Census tracts with high CVMs are represented by positive percentages in orange and red. A lower CVM is associated with lower projected impacts of climate change, shown in yellow, while a negative CVM value represents a projected beneficial impact of climate change (e.g., through reductions in deaths caused by extremely cold winter weather). Negative CVMs are represented by negative percentages in blue.

## **IV. Fiscal Impacts**

### **A. Local Government**

The Proposed Amendments will impact local governments through increased compliance costs and abatement capital outlays for POU, increased revenue from POU allowance sales, and impacts to local tax and fee revenues, which are summarized in Table 22.

#### **Publicly Owned Utilities (POU) Compliance Costs**

Some local government entities, such as electricity generators owned by POU, are covered by the Cap-and-Trade Program, and may see an increased compliance obligation under the Proposed Amendments. POU also receive free allowance allocation each year in an amount that is designed to address expected Cap-and-Trade Program compliance costs. The Proposed Amendments update the total number of allowances allocated to POU during 2025-2030, establish allowance allocation for EDUs post-2030, and also require all allowances allocated to POU to be consigned to auction, with the proceeds used to reduce utility GHG emissions and benefit ratepayers. Under the current Regulation, POU can choose to use any amount of their allocated allowances for direct Program compliance, with the remainder of allocated allowances getting consigned to auction. Staff analysis assumes that, in line with historic trends, much of the increase in revenues to POU associated with the requirement to consign allocated allowances to auction will be spent on renewable electricity generation and procurement, and the staff analysis includes these revenues when calculating net electricity sector abatement costs. Separately, some historic uses of GGRF proceeds have provided direct fiscal benefits to local governments (e.g., for climate change planning or resiliency projects), and the staff analysis projects a marginal increase in revenues available for these programs.

California's POU receive 28% of all allowances allocated to EDUs and 2% of all allowances allocated to natural gas utilities. To calculate the POU share of compliance and abatement costs, these percentages were multiplied by total utility-sector compliance and abatement costs for electricity and natural gas. During 2025-2046, POU are expected to have a total compliance and abatement cost of \$3.7 billion above baseline expectations.

#### **Local Government Fee and Tax Revenue**

Local government revenues are expected to increase by \$11.3 billion from additional allowance sales, sales tax collected from abatement capital outlay purchases, and potential increases in revenues from increased energy costs. Additionally, local governments may see a decrease of \$943 million in the Natural Gas Surcharge collected on natural gas sales.

#### **POU Revenue from Allowance Sales**

POU receive revenue from consignment sales of utility allowance allocations. During 2025-2046, POU are expected to have 91.9 million additional allocated allowances and \$7.97 billion in additional revenue from these allocated allowance sales as displayed in Table 21 using an estimated allowance value of \$60.



Table 21: Proposed POU Allocated Allowances Consigned to Auction and Projected Increase in Revenues for Publicly Owned Utilities

Year	Number of Additional Allocated Allowances Above Baseline (million)	Projected Revenue Increase Above Baseline (\$ million)
2025	4.1	\$462
2026	2.5	\$364
2027	3.4	\$386
2028	4.3	\$414
2029	4.1	\$398
2030	3.8	\$377
2031	5.4	\$430
2032	5.3	\$419
2033	5.1	\$408
2034	5.0	\$397
2035	4.8	\$386
2036	4.7	\$375
2037	4.6	\$364
2038	4.4	\$353
2039	4.3	\$342
2040	4.1	\$331
2041	4.0	\$319
2042	3.9	\$308
2043	3.7	\$297
2044	3.6	\$286
2045	3.4	\$275
2046	3.4	\$275
<b>Total</b>	<b>91.9</b>	<b>\$7,965</b>

### Sales Tax on Capital Abatement Equipment

Sales taxes are levied in California to fund a variety of programs at the state and local level. The Proposed Amendments would increase capital purchases associated with abatement activities. The average sales tax rate in California is 8.7% with 4.8% going to local governments and 3.9% going to State government (CARB 2023h). During 2025-2046, sales tax is expected to increase by \$886 million.

### Transportation Fuels Sales Tax

Implementation of the Proposed Amendments may increase the retail cost of gasoline. California’s gasoline sales tax rate is 2.25% with all revenue going to local government. To estimate the additional gasoline sales tax, the 2.25% tax rate was applied to the overall increased cost of gasoline purchases. During 2025-2046, the additional taxes collected are estimated to increase local government revenue by \$504 million.

Implementation of the Proposed Amendments may increase the retail cost of diesel. California diesel sales tax of 14.45% was used in this analysis. This is comprised of a 13% diesel tax and a 1.45% district tax, with 4.76% going to local governments and 9.69% going to state

government. During 2025-2046, the additional taxes collected are expected to increase local government revenue by \$369 million.

### **Utility User Tax (UUT)**

Many cities and counties in California levy a Utility User Tax (UUT) on electricity and natural gas usage. This tax varies across cities and ranges from no tax to 11%. The population-weighted average value of 3.45% was applied to electricity and natural gas demand forecasts to determine changes to UUT revenue.

The UUT may increase by \$1.5 billion for electricity and decrease by \$943 million for natural gas, as use of electricity increases and natural gas usage decreases. The overall impact to the UUT is an expected increase of \$603 million over the lifetime of the Proposed Amendments.

Table 22: Summary of Fiscal Impacts to Local Government (\$ million)

Year	POU Compliance and Abatement Costs	POU Allowance Sales Revenue	Sales Tax Revenue	UUT - Natural Gas Revenue	UUT - Electricity Revenue	Transportation Fuels Sales Tax Revenue	Total Revenue Increase	Total Revenue Decrease	Net Fiscal Change
2025	(589)	462	10	(3)	5	23	499	(3)	(93)
2026	(531)	364	12	(6)	10	24	410	(6)	(128)
2027	(479)	386	13	(9)	15	25	439	(9)	(49)
2028	(374)	414	35	(15)	27	26	502	(15)	112
2029	(203)	398	83	(21)	38	28	547	(21)	323
2030	(168)	377	88	(27)	49	29	543	(27)	348
2031	(209)	430	65	(31)	54	30	579	(31)	339
2032	(184)	419	66	(34)	59	32	575	(34)	357
2033	(156)	408	70	(38)	64	33	575	(38)	381
2034	(135)	397	65	(41)	69	35	565	(41)	390
2035	(110)	386	65	(44)	73	37	561	(44)	407
2036	(165)	375	42	(48)	79	39	534	(48)	322
2037	(141)	364	33	(51)	84	41	521	(51)	329
2038	(116)	353	33	(54)	88	43	516	(54)	346
2039	(84)	342	41	(57)	93	45	520	(57)	379
2040	(65)	331	32	(60)	98	47	508	(60)	382
2041	(41)	319	26	(62)	100	49	496	(62)	393
2042	(12)	308	34	(65)	104	52	499	(65)	422
2043	10	297	25	(67)	107	55	484	(67)	427
2044	35	286	25	(68)	109	57	478	(68)	444
2045	31	275	21	(71)	113	60	470	(71)	430
2046	15	275	0	(69)	110	63	449	(69)	394
<b>Total</b>	<b>(3,671)</b>	<b>7,965</b>	<b>886</b>	<b>(943)</b>	<b>1,546</b>	<b>873</b>	<b>11,271</b>	<b>(943)</b>	<b>6,657</b>

## **B. State Government**

### **Cap-and-Trade Program Implementation**

Some public university campuses in the University of California and California State University systems are considered State government entities and are covered facilities in the Cap-and-Trade Program. These public universities receive free allowance allocation each year in an amount that is calculated based on historic energy use and that declines each year in proportion with the annual allowance budgets. Unlike POU's, universities may use their entire allowance allocation for direct Program compliance. Allowance allocation will continue to decline in line with future Program budgets, but under the Proposed Amendments covered universities will still be allowed to use their allocation directly for compliance.

State revenues may increase with additional sales tax collected from abatement capital outlay purchases and potential transportation fuel expenditures. State government may see an increase in the ERF collected on electricity sales and a decrease in the Natural Gas Surcharge collected on natural gas sales.

Finally, any change in administrative costs for CARB to implement the Cap-and-Trade Program is expected to be minimal, and any implementation changes could be accommodated through a redistribution of existing resources.

### **GGRF Revenues**

Revenues from the auction of state-owned allowances are expected to increase under the Proposed Amendments. Even though covered emissions under the Proposed Scenarios are lower than in the Baseline Scenario, the anticipated increase in allowance prices makes up for the shortfall in total number of allowances sold at auction. State government may receive a projected \$8.4-\$12.2 billion in increased revenue raised from allowance auctions.

GGRF revenues are appropriated by the Legislature and Governor as part of the annual budgeting process for programs that further reduce GHG emissions and benefit priority populations. GGRF revenues are often distributed through grant programs administered by State agencies, though some revenues are expended directly by agencies themselves (e.g., forest protection work conducted by CalFIRE). Projected increases in GGRF revenues may increase the funds available for these programs. Staff analysis assumes that these increased revenues will be distributed in proportion to historic appropriations, and no new GGRF programs will be created. Given these assumptions, any increase in state administrative costs to distribute these funds is expected to be minimal.

### **Sales Tax on Abatement Equipment Purchases**

As discussed in the Fiscal Impacts to Local Government section, the existing sales tax is applied to purchases of capital equipment for abatement. The state portion of the sales tax is 3.94%. During 2025-2046, the Proposed Amendments would increase sales tax collected by \$721 million.

### **Energy Resource Fee (ERF)**

The ERF is a California state existing surcharge of \$0.0003/kWh levied on consumers of electricity purchased from electrical utilities. The ERF surcharge is multiplied by the forecasted

electricity demand, which grows under the Proposed Amendments relative to the Baseline Scenario. ERF revenues may increase by \$67 million as electricity use increases.

### **Natural Gas Surcharge**

The existing Natural Gas Surcharge is a California state surcharge of \$0.0887/therm of energy. The Natural Gas Surcharge is used to fund rate reductions and home weatherization services for low-income electric and gas customers of public utility corporations. The Natural gas surcharge is multiplied by the forecasted natural gas demand, which declines under the Proposed Amendments. Natural Gas Surcharge revenues may decrease by \$2.6 billion as use of natural gas declines.

### **Diesel Sales Tax**

CARB anticipates the implementation of the Proposed Amendments may increase the retail cost of diesel but note retail prices are driven more by a variety of factors outside of implementation of existing environmental regulations as described in Section 3.D. A state diesel sales tax of 9.69% was applied to forecasted retail diesel fuel purchases to calculate additional sales tax revenue. The diesel sales tax may increase state government revenues by \$752 million.

Table 23 displays all revenue changes to State government under the Proposed Amendments. Over the regulatory horizon the State is expected to increase total revenue collected by an estimated \$11.2 billion with \$9.7 billion from GGRF revenue and \$1.5 billion from sales and fuel taxes. The State is expected to see a decline of an estimated \$2.6 billion from natural gas tax revenue as natural gas use is replaced by electricity and low-carbon fuels.

Table 23: Change in State Revenues by Year (\$ million)

Year	GGRF Revenue	Sales Tax Revenue	ERF Revenue	Natural Gas Tax Revenue	Diesel Sales Tax Revenue	Total Revenue Increase	Total Revenue Decrease	Net Change in Revenues
2025	2,026	8	0	(8)	20	2,054	(8)	2,045
2026	1,755	10	0	(17)	21	1,785	(17)	1,768
2027	1,519	10	1	(25)	22	1,551	(25)	1,527
2028	1,317	28	1	(43)	23	1,369	(43)	1,326
2029	1,145	68	2	(59)	24	1,239	(59)	1,180
2030	1,003	72	2	(76)	25	1,101	(76)	1,026
2031	933	53	2	(86)	26	1,015	(86)	930
2032	816	54	3	(95)	27	900	(95)	804
2033	698	57	3	(105)	29	787	(105)	682
2034	580	53	3	(114)	30	667	(114)	553
2035	463	53	3	(123)	32	551	(123)	428
2036	345	34	3	(133)	33	416	(133)	283
2037	228	27	4	(142)	35	293	(142)	152
2038	110	27	4	(150)	37	177	(150)	27
2039	(8)	33	4	(159)	39	76	(167)	(91)
2040	(125)	26	4	(168)	41	71	(293)	(222)
2041	(243)	21	4	(173)	43	68	(416)	(348)
2042	(361)	28	5	(180)	45	77	(541)	(463)
2043	(478)	21	5	(185)	47	72	(663)	(591)
2044	(596)	20	5	(190)	49	74	(785)	(711)
2045	(713)	17	5	(197)	52	74	(910)	(836)
2046	(713)	0	5	(193)	54	59	(906)	(847)
<b>Total</b>	<b>9,700</b>	<b>721</b>	<b>67</b>	<b>(2,620)</b>	<b>752</b>	<b>11,240</b>	<b>(2,620)</b>	<b>8,621</b>

## V. Macroeconomic Impacts

### A. Methods for Determining Economic Impacts

This section describes the estimated total economic impact of the Proposed Scenarios on the California economy. The Proposed Scenarios would result in direct compliance costs, abatement costs, and cost-savings for covered entities relative to the Baseline Scenario. Changes in production costs will directly affect sales for covered entities and for industries supplying GHG abatement technologies.

These direct and indirect effects would lead to induced effects, such as changes in personal income that affect consumer expenditures across other spending categories. The total economic impact is the sum of these effects and is presented in this section. The total economic impact of the Proposed Scenarios is simulated relative to the Baseline Scenario using the cost estimates described in Section III and non-mortality benefits described in Section II. The analysis focuses on the changes in major macroeconomic indicators during

2025-2046, including employment, output, personal income, and gross state product (GSP). The years of the analysis are used to simulate the Proposed Amendments through more than 12 months post full implementation.

Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 3.1 is used to estimate the macroeconomic impacts of the Proposed Amendments on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric, and economic geography methodologies.<sup>49</sup> REMI Policy Insight Plus provides year-by-year estimates of the total impacts of the Proposed Amendments, pursuant to the requirements of SB 617 (Calderon and Pavley, Chapter 496, Statutes of 2011) and the CDF. Staff used the REMI single region, 160 sector model with the model reference case adjusted to reflect California CDF's most current publicly available economic and demographic projections (per the SRIA requirements set forth in Title 1, Division 3, Chapter 1 of the California Code of Regulations).

Specifically, the REMI model's National and Regional Control was updated to conform to the CDF economic forecasts. These include U.S. Real Gross Domestic Product, income, and employment, as well as California civilian employment by industry, released with the 2024-2025 Governor's Budget on January 10, 2024, and CDF demographic forecasts for California population forecasts, last updated in July 2023 (CDF 2024a, CDF 2024b, CDF 2024c, CDF 2023). Where the CDF economic forecasts end in 2027, CARB staff analysis includes assumptions that economic variables would revert back to the REMI baseline forecasts.

## **B. Inputs and Assumptions of the Assessment**

The estimated economic impact of the Proposed Amendments is sensitive to modeling assumptions. This section provides a summary of the assumptions and inputs used to determine the suite of policy variables that best reflect the macroeconomic impacts of the Proposed Amendments. The direct costs and savings estimated in Section III and the non-mortality related health benefits estimated in Section II are translated into REMI policy variables and used as inputs for the macroeconomic analysis.<sup>50</sup> As detailed in Section III, the Proposed Scenarios would result in an increase in both compliance costs and abatement costs for covered facilities.<sup>51</sup> As described in Section III.D, a portion of this cost is assumed to pass-through to individual and business energy consumers, while the remaining portion is assumed to directly increase some production costs for facilities.

The distribution of these potential pass-through costs across individuals and businesses is assumed to be proportional to their share of energy consumption in the economy (See Appendix C, Table 51 for the individual and industry-level shares). Pass-through costs to individuals are input into the model as a reduction in disposable income, representing how increased energy costs may reduce consumption of other goods and services. Pass-through costs to business energy consumers are input into the model as an increase in production

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<sup>49</sup> For further information and model documentation see the [Pi+ webpage](#).

<sup>50</sup> Refer to the Macroeconomic Appendix for a full list of REMI inputs for this analysis.

<sup>51</sup> Compliance costs are provided in 2023 dollars and abatement costs are adjusted to 2023 dollars based on an inflation forecast, since annual California CPI for 2023 was unavailable at the time of drafting the SRIA. Costs are input into the REMI model as 2022 dollars.

costs. Compliance costs and abatement costs that are not assumed to be directly passed through are input into the model as a direct increase in some production for the industry that includes a given covered facility.

Abatement cost and cost-savings would result in corresponding changes in final demand for industries supplying those particular goods or services as shown in Table 24. As described in Section III.A, the purchase of abatement equipment would include electric boilers, heat pumps, and solar thermal equipment. This equipment is modeled as being provided by the Boiler, tank, and shipping container manufacturing (NAICS code 3324), Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing (3334), and Semiconductor and other electronic component manufacturing (3344) industries. A portion of the equipment cost will go towards any associated installation and construction costs, which is modeled as provided by the construction sector (23). The reduction in natural gas combustion is modeled as reduced sales for the Natural gas distribution industry (2212). As energy consumers reduce natural gas use, they will substitute towards electricity and hydrogen fuel, which is modeled as increased sales for the Electric power generation, transmission, and distribution (2211) and Basic chemical manufacturing (3251) industries.

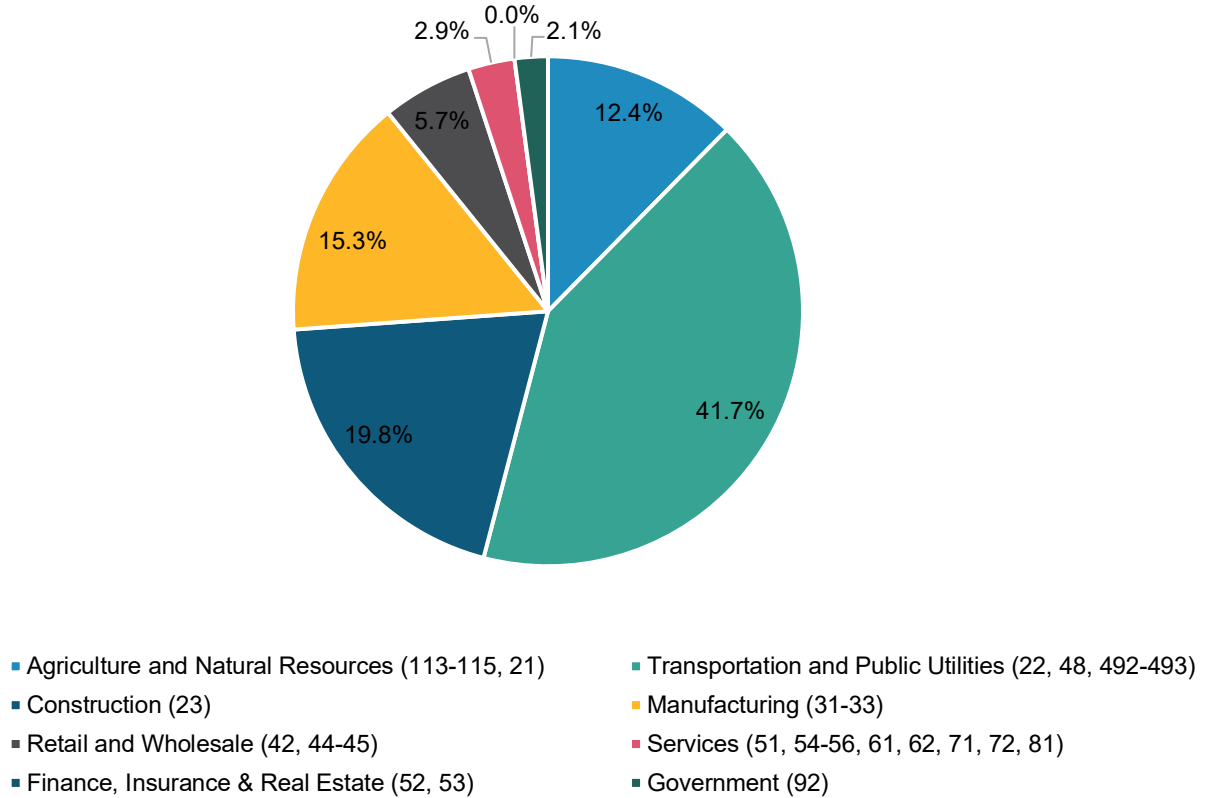
Table 24. Sources of Changes in Production Costs and Final Demand by Industry from Abatement Activities

<b>Source of Cost or Savings for Covered Facilities</b>	<b>Industries with Changes in Final Demand (NAICS code)</b>
Capital (Abatement) Equipment	<i>Upfront cost:</i> Boiler, tank, and shipping container manufacturing (3324), Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing (3334), Semiconductor and other electronic component manufacturing (3344)
Equipment Installation	<i>Upfront cost:</i> Construction (23)
Natural Gas	<i>Recurring cost:</i> Natural gas distribution (2212)
Electricity	<i>Recurring cost:</i> Electric power generation, transmission, and distribution (2211)
Hydrogen fuel	<i>Recurring cost:</i> Basic chemical manufacturing (3251)

Compliance costs correspond to the proceeds from allowance auctions, which are a transfer from businesses to government or other businesses. As described in Section II, revenue generated by the sale of allowances at auctions, which goes to the GGRF, is spent on projects that benefit communities and increase output for industries that develop them. This spending on GGRF projects is modeled as an increase in exogenous final demand for industries. The share of spending by major sector is illustrated in Figure 7.



Figure 7. Share of Historical GGRF Appropriations by Major Sector



The estimated increase in POU spending on energy efficiency, electrification, infrastructure, and ZEV incentives (see Section IV.A), is modeled as an increase in exogenous final demand on industries providing these goods and services (See Appendix B for detailed policy variables). The ZEV incentives are modeled as an increase in disposable income for individuals in California.

The non-mortality related health benefits resulting from the PM<sub>2.5</sub> and NO<sub>x</sub> emission reductions of the Proposed Amendments reduce healthcare costs and reduce work-loss days for individuals on average. The reduction in healthcare costs is modeled as a decrease in spending for hospitals, with a reallocation of this spending towards other goods and increased savings. The reduction in work-loss days is modeled as an increase in labor productivity across the economy.

The GHG emissions reduction benefits as valued through the social cost of carbon emissions (SC-CO<sub>2</sub>) represent the avoided damage from climate change worldwide per MTCO<sub>2</sub>e. These benefits, or other ways to assess the economic impact in California of reduced greenhouse gas emissions from the Proposed Amendments, fall outside the scope and capability of our economic model and are not evaluated here.

### C. Results of the Assessment

Following are the detailed results of the economic impact assessment shown for Proposed Scenario B. This scenario is chosen for presenting detailed results because it represents the

median costs across the three proposals considered here, and the other proposals will generally follow a similar trend by having slightly lower or higher impacts depending on the magnitude of costs.

### **California Employment Impacts**

Table 25 presents the impact of the Proposed Scenario B on total employment in California across all industries. Employment comprises estimates of the number of jobs, full-time plus part-time, by place of work for all industries. Full-time and part-time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included. The employment impacts represent the net change in employment, which consists of positive impacts for some industries and negative impacts for others.

The California economy is forecast to grow between 2025 and 2046. The job impacts of Proposed Scenario B vary over the course of the regulatory horizon reflecting the timing of costs and when various abatement technology and GGRF investments are made. As shown in Table 25 and Figure 8, there is a slightly negative job impact in each year that diminishes through the end of the regulatory horizon. The results are further described at the industry level in the following paragraph. These changes in employment do not exceed 0.1% of baseline California employment across the entire regulatory horizon.

Table 25. Total Employment Impacts, Proposed Scenario B

<b>Year</b>	<b>California Employment</b>	<b>% Change</b>	<b>Change in Total Jobs</b>
2026	25,562,513	-0.10%	-26,376
2030	25,949,429	-0.05%	-13,837
2034	26,433,498	-0.09%	-24,090
2038	26,806,428	-0.11%	-30,089
2042	27,204,449	-0.08%	-22,668
2046	27,602,685	-0.04%	-10,187
<b>Annual Average</b>	<b>26,539,768</b>	<b>-0.09%</b>	<b>-23,002</b>

The total employment impacts shown in Table 25 are net of changes at the industry level. Figure 8 shows these job impacts by major sector as a percent of total California employment. Table 26 shows the changes in employment by industries that would be primarily impacted by incurring direct costs or would be secondarily impacted by a direct change in industry sales as a result of the Proposed Scenario B.

As the requirements of the Proposed Scenarios are implemented, the modeling indicates employment growth tends to decline in both industries facing increases in production costs, due to the cost of allowances or abatement activities, and energy consumers, who are assumed to have costs passed through to them via energy prices. As illustrated in Figure 8, the manufacturing and natural resources sectors, which would experience direct costs, have negligible negative employment impacts, while the retail and services sectors see negligible negative employment impacts due to reduced consumer spending on their goods and services. Slightly positive employment impacts are estimated to occur towards the end of the regulatory horizon in sectors expected to see a substantial increase in sales resulting from increased abatement activity, including public utilities and construction, due to increased electricity demand and capital equipment installation.

Figure 8. Job Impacts by Major Sector

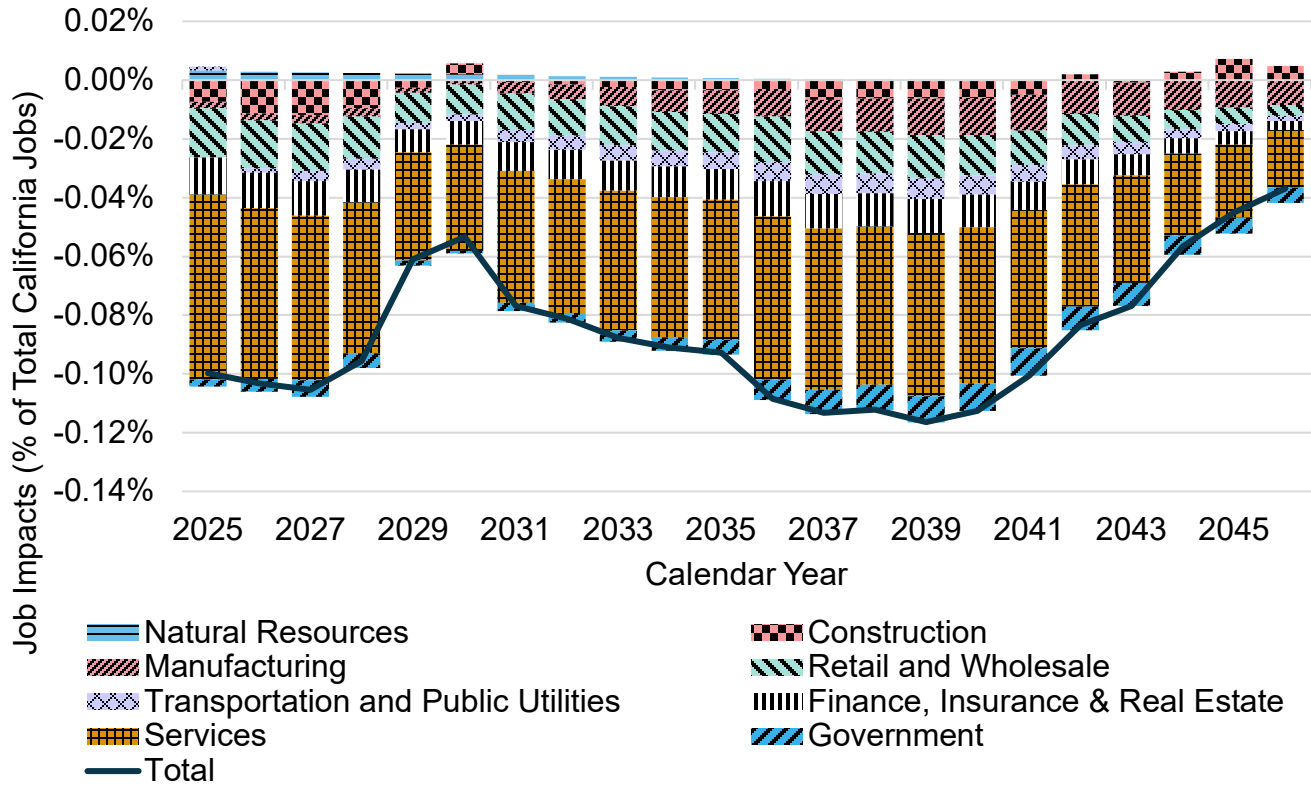


Table 26. Employment Impacts by Primary and Secondary Industry

Year	Nonmetallic mineral mining and quarrying (2123)		Electric power generation, transmission and distribution (2211)		Natural gas distribution (2212)		Construction (23)		Fruit and vegetable preserving and specialty food manufacturing (3114)		Glass and glass product manufacturing (3272)		Cement and concrete product manufacturing (3273)		Petroleum and coal products manufacturing (324)	
	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs
2026	-0.16%	-13	-0.48%	-205	-1.19%	-161	-0.22%	-2,862	-0.11%	-29	0.15%	11	0.59%	108	-0.14%	-16
2030	-0.19%	-14	1.92%	792	-3.51%	-469	0.08%	1,002	-0.28%	-75	0.03%	2	0.44%	80	-0.12%	-13
2034	-0.86%	-66	2.84%	1,110	-6.49%	-847	-0.07%	-934	-0.97%	-257	-0.77%	-51	-1.35%	-247	-0.20%	-22
2038	-1.34%	-102	3.84%	1,432	-8.85%	-1,130	-0.13%	-1,691	-1.38%	-361	-1.68%	-111	-3.10%	-572	-0.25%	-28
2042	-1.39%	-105	4.66%	1,653	-10.46%	-1,303	0.04%	526	-1.64%	-424	-2.32%	-154	-4.15%	-770	-0.22%	-25
2046	-0.008	-60	4.99%	1679	-10.92%	-1,323	0.11%	1361	-1.11%	-283	-2.03%	-137	-0.038	-701	-0.09%	-10
<b>Annual Average</b>	<b>-0.84%</b>	<b>-64</b>	<b>2.88%</b>	<b>1058</b>	<b>-6.78%</b>	<b>-861</b>	<b>-0.06%</b>	<b>-786</b>	<b>-0.93%</b>	<b>-243</b>	<b>-1.09%</b>	<b>-72</b>	<b>-1.86%</b>	<b>-344</b>	<b>-0.18%</b>	<b>-20</b>

Table 26. Employment Impacts by Primary and Secondary Industry (continued)

Year	Basic chemical manufacturing (3251)		Wholesale trade (42)		Retail trade (44-45)		Transportation and Warehousing (48, 492-493)		State & Local Government	
	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs	% Δ	Δ Jobs
2026	0.18%	15	-0.10%	-717	-0.17%	-3,464	0.00%	-45	-0.05%	-1,119
2030	0.61%	48	-0.06%	-441	-0.11%	-2,176	-0.06%	-963	-0.01%	-237
2034	0.87%	66	-0.10%	-694	-0.14%	-2,761	-0.11%	-1,729	-0.05%	-1,212
2038	1.04%	80	-0.12%	-833	-0.16%	-2,993	-0.13%	-2,098	-0.09%	-2,328
2042	1.33%	103	-0.09%	-663	-0.12%	-2,218	-0.10%	-1,698	-0.08%	-2,194
2046	2.16%	170	-0.04%	-260	-0.04%	-754	-0.05%	-837	-0.05%	-1,458
<b>Annual Average</b>	<b>0.95%</b>	<b>74</b>	<b>-0.09%</b>	<b>-649</b>	<b>-0.13%</b>	<b>-2,573</b>	<b>-0.08%</b>	<b>-1,336</b>	<b>-0.06%</b>	<b>-1,507</b>

## California Business Impacts

Gross output is used as a measure of business impacts as it represents an industry’s sales or receipts and tracks the quantity of goods or services produced in a given time period. Output growth is the sum of output in each private industry and State and local government, as it contributes to the State’s GDP and is affected by production cost and demand changes. As production cost increases or demand decreases, output is expected to contract, but as production costs decline or demand increases, industry would likely experience output growth.

California output is forecast to grow by \$3.11 trillion between 2025 and 2046. Proposed Scenario B would result in a negligible decrease in output in each year, which diminishes through the end of the regulatory horizon as shown in Table 27.

Table 27. Change in Output Growth

Year	California Output	% Δ	Δ (2022M\$)
2026	6,096,761	-0.10%	-6,206
2030	6,621,907	-0.05%	-2,984
2034	7,207,603	-0.08%	-6,126
2038	7,766,303	-0.11%	-8,432
2042	8,395,198	-0.08%	-7,113
2046	9,081,119	-0.04%	-3,504
<b>Annual Average</b>	<b>7,445,957</b>	<b>-0.08%</b>	<b>-6,191</b>

Figure 9 shows changes to economic output as a percent of total California output, and Table 28 shows changes in output by industry. Similar to the employment impacts, sectors generally realizing production cost increases or reduced sales have a reduction in output. Impacts to economic impact are not proportional to the employment impacts due to differences in labor productivity across industries. While the public utilities sector is estimated to see a large increase in demand, the job impacts for the public utilities and transportation sector are relatively small due to high labor productivity compared to the services or retail sectors.

Figure 9. Change in Output by Major Sector

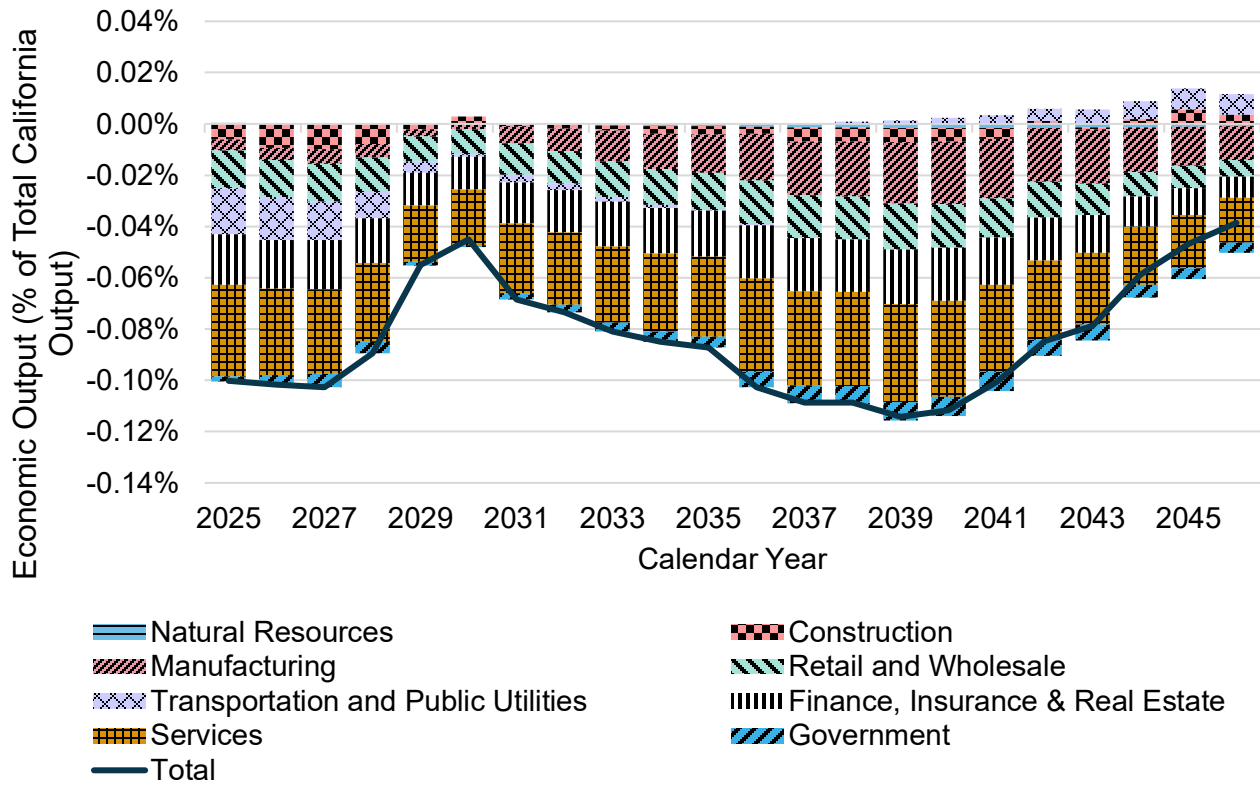


Table 28. Change in Output by Primary and Secondary Industries

Year	Nonmetallic mineral mining and quarrying (2123)		Electric power generation, transmission and distribution (2211)		Natural gas distribution (2212)		Construction (23)		Fruit and vegetable preserving and specialty food manufacturing (3114)		Glass and glass product manufacturing (3272)		Cement and concrete product manufacturing (3273)	
	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)
2026	-0.16%	-7	-0.48%	-237	-1.19%	-149	-0.22%	-563	-0.11%	-11	0.15%	4	0.59%	36
2030	-0.19%	-9	1.93%	979	-3.52%	-465	0.07%	196	-0.29%	-30	0.03%	1	0.45%	29
2034	-0.87%	-42	2.85%	1,478	-6.53%	-904	-0.08%	-219	-0.99%	-109	-0.78%	-20	-1.36%	-96
2038	-1.37%	-70	3.86%	2,043	-8.92%	-1,294	-0.14%	-418	-1.41%	-162	-1.71%	-45	-3.15%	-242
2042	-1.43%	-77	4.68%	2,536	-10.56%	-1,609	0.03%	95	-1.68%	-200	-2.36%	-66	-4.23%	-353
2046	-0.84%	-47	5.01%	2,780	-11.03%	-1,764	0.10%	331	-1.15%	-142	-2.08%	-62	-3.86%	-350
<b>Annual Average</b>	<b>-0.85%</b>	<b>-44</b>	<b>2.90%</b>	<b>1,547</b>	<b>-6.84%</b>	<b>-1,003</b>	<b>-0.07%</b>	<b>-180</b>	<b>-0.96%</b>	<b>-111</b>	<b>-1.11%</b>	<b>-30</b>	<b>-1.89%</b>	<b>-157</b>

Table 28. Change in Output by Primary and Secondary Industries (continued)

Year	Petroleum and coal products manufacturing (324)		Basic chemical manufacturing (3251)		Wholesale trade (42)		Retail trade (44-45)		Transportation and Warehousing (48, 492-493)		State & Local Government	
	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)
2026	-0.14%	-85	0.18%	37	-0.10%	-330	-0.17%	-562	-0.31%	-642	-0.05%	-247
2030	-0.12%	-72	0.61%	122	-0.06%	-230	-0.11%	-410	-0.26%	-600	-0.01%	-54
2034	-0.21%	-129	0.88%	176	-0.10%	-407	-0.15%	-599	-0.26%	-670	-0.05%	-285
2038	-0.26%	-171	1.04%	222	-0.13%	-554	-0.17%	-750	-0.25%	-691	-0.09%	-559
2042	-0.24%	-167	1.33%	300	-0.11%	-517	-0.14%	-663	-0.18%	-542	-0.08%	-539
2046	-0.11%	-82	2.16%	517	-0.05%	-271	-0.06%	-314	-0.09%	-297	-0.05%	-367
<b>Annual Average</b>	<b>-0.19%</b>	<b>-125</b>	<b>0.95%</b>	<b>208</b>	<b>-0.10%</b>	<b>-409</b>	<b>-0.14%</b>	<b>-586</b>	<b>-0.24%</b>	<b>-603</b>	<b>-0.06%</b>	<b>-360</b>



## Impacts on Investments in California

Private domestic investment consists of purchases of residential and nonresidential structures, equipment, and software by private businesses and nonprofit institutions. It is used as a proxy for impacts on investments in California because it provides an indicator of the future productive capacity of the economy.

The relative changes to growth in domestic private investment for Proposed Scenario B are shown in Table 29. Private domestic investment is estimated to slightly decrease in each year, with this effect diminishing and turning slightly positive through the end of the regulatory horizon.

Table 29. Change in Gross Private Domestic Investment Growth

Year	Private Investment (2022M\$)	% Change	Change (2022M\$)
2026	532,412	-0.29%	-1,527
2030	591,151	-0.12%	-683
2034	634,376	-0.17%	-1,062
2038	673,314	-0.20%	-1,338
2042	716,647	-0.14%	-984
2046	762,867	0.01%	81
<b>Annual Average</b>	<b>646,331</b>	<b>-0.16%</b>	<b>-1,020</b>

## Impacts on Individuals in California

The Proposed Amendments would impose no direct costs on individuals in California. However, the costs incurred by affected businesses and the public sector may be passed through the economy and affect individuals.

One measure of this impact is the change in real personal income, which is income received from all sources, including employee compensation and government and business transfer activity, adjusted for inflation. This is an aggregate statewide measure of personal income change, representing a net of income lost from jobs foregone in some sectors and jobs gained in other sectors. Personal income is projected to grow from \$77,000 in 2025 to \$110,000 in 2046. Table 30 estimates the annual change in real personal income across all individuals in California due to Proposed Scenario B relative to the Baseline Scenario. The change in total personal income is negligible across the full scope of implementation. The change in total personal income estimated here can also be divided by the California population to show the average or per capita impact on personal income. The change in personal income growth is also estimated to be negligible.<sup>52</sup>

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<sup>52</sup> The sign of the change in personal income per capita differs from overall personal income due to population growth changes estimated by the REMI model as a result of the Proposed Scenarios.

Changes in personal income in California may change the amount of revenue the State of California collects in personal income tax. Based on these results personal income tax revenues may decrease in the same proportions as personal income; about \$0.17 billion on average annually or approximately a 0.11% reduction.<sup>53</sup>

Table 30. Impacts on Personal Income in California from Proposed Scenario B

Year	Personal Income (2022M\$)	% Change	Change (2022M\$)	Personal Income per capita (2022\$)	% Change	Change (2022\$)
2026	3,171,348	-0.10%	-3,174	79,272	-0.07%	-52
2030	3,320,894	-0.08%	-2,687	82,467	-0.02%	-19
2034	3,613,267	-0.12%	-4,300	89,048	-0.04%	-36
2038	3,891,173	-0.14%	-5,544	95,387	-0.04%	-41
2042	4,186,680	-0.13%	-5,246	102,418	-0.02%	-23
2046	4,502,426	-0.05%	-2,464	110,155	0.02%	17
<b>Annual Average</b>	<b>3,732,910</b>	<b>-0.11%</b>	<b>-4,171</b>	<b>92,108</b>	<b>-0.04%</b>	<b>-31</b>

### Impacts on Gross State Product

Gross State Product (GSP) is the market value of all goods and services produced in California and is one of the primary indicators of economic growth. It is calculated as the sum of the dollar value of consumption, investment, net exports, and government spending. Under Proposed Scenario B, GSP growth is anticipated to decrease slightly relative to the Baseline Scenario in each year, with this effect diminishing and turning slightly positive through the end of the regulatory horizon as shown in Table 31. These changes do not exceed 0.11% of the GSP in the Baseline Scenario. This metric summarizes impacts discussed above, including output, investment, and government spending.

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<sup>53</sup> The change in personal income tax is estimated based on a statewide average tax rate of about 4%.

Table 31. Change in Gross State Product

Year	GSP (2022M\$)	% Change	Change (2022M\$)
2026	3,616,806	-0.10%	-3,520
2030	3,923,402	-0.04%	-1,595
2034	4,213,916	-0.08%	-3,307
2038	4,490,192	-0.10%	-4,530
2042	4,782,675	-0.08%	-3,710
2046	5,092,286	-0.04%	-1,826
<b>Annual Average</b>	<b>4,316,453</b>	<b>-0.08%</b>	<b>-3,341</b>

### **Creation or Elimination of Businesses**

The REMI model cannot directly estimate the creation or elimination of businesses. However, changes in jobs and output for the California economy described above can be used to understand some potential impacts. The overall jobs and output impacts of the Proposed Amendments are small relative to the total California economy, representing changes of no greater than 0.2%. However, impacts on specific industries may be larger as described in previous sections. The trend of increasing demand for electricity in the electric power sector similarly sees large increases in sales, but its services are provided primarily by existing utilities. New utilities are not expected to be created to meet this increased demand. The trend of increasing demand for hydrogen and the availability of incentives may provide opportunities for the creation of new businesses. The trend of decreasing demand for natural gas has the potential to result in the elimination of upstream or downstream businesses.

### **Incentives for Innovation**

By imparting a long-term price signal on the combustion of fossil energy, the Program provides a direct incentive for innovation toward more efficient, low-carbon processes and energy. These investments are included in this analysis as abatement costs attributed to a more stringent Cap-and-Trade Program (see Section III.A.2., GHG Emissions Abatement Costs). While these abatement costs are assumed to be constant and reflect contemporaneous installation and operation cost data, facilities covered by the Program have a continued incentive for additional technological innovation that may drive abatement costs lower in future years.

### **Competitive Advantage or Disadvantage**

The Proposed Amendments increase the stringency of the Cap-and-Trade Program, which strengthens the incentive to use low-carbon energy sources and production methods within the State. This incentive may provide a competitive advantage to in-state businesses that decarbonize their operations.

Separately, the Program includes allowance allocation for industrial facilities in emissions-intensive, trade-exposed sectors that is designed to minimize the competitive disadvantage for in-state firms relative to out-of-state competitors that are not regulated by a similar regulation.

Industrial allowance allocation is critical to minimize emissions leakage and maintain an incentive for clean, efficient production within the State of California.

### **Summary and Agency Interpretation of the Assessment Results**

The results of the macroeconomic analysis of the Proposed Scenario B are summarized in Table 32. As analyzed here, CARB estimates the Proposed Scenario B would be unlikely to have a significant impact on the California economy. Overall, the change in the growth of jobs, State GDP, personal income, investment, and output is projected to not exceed 0.3% of the baseline. While the Proposed Amendments would initially result in slightly decreased growth across affected sectors of the economy, these impacts diminish towards the end of the regulatory horizon. Both the construction and electric power industries would see positive growth under the Proposed Amendments by providing their services for abatement activities. The GHG emissions reductions achieved through reduced combustion represent some reduced sales by the natural gas, propane, and gasoline industry, reducing employment in those industries and industries upstream.

Table 32. Summary of Macroeconomic Impacts of the Proposed Scenario B

Year	GSP		Personal Income		Employment		Output		Private Investment	
	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ Jobs	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)
2026	-0.10%	-3,520	-0.10%	-3,174	-0.10%	-26,376	-0.10%	-6,206	-0.29%	-1,527
2030	-0.04%	-1,595	-0.08%	-2,687	-0.05%	-13,837	-0.05%	-2,984	-0.12%	-683
2034	-0.08%	-3,307	-0.12%	-4,300	-0.09%	-24,090	-0.08%	-6,126	-0.17%	-1,062
2038	-0.10%	-4,530	-0.14%	-5,544	-0.11%	-30,089	-0.11%	-8,432	-0.20%	-1,338
2042	-0.08%	-3,710	-0.13%	-5,246	-0.08%	-22,668	-0.08%	-7,113	-0.14%	-984
2046	-0.04%	-1,826	-0.05%	-2,464	-0.04%	-10,187	-0.04%	-3,504	0.01%	81
<b>Annual Average</b>	<b>-0.08%</b>	<b>-3,341</b>	<b>-0.11%</b>	<b>-4,171</b>	<b>-0.09%</b>	<b>-23,002</b>	<b>-0.08%</b>	<b>-6,191</b>	<b>-0.16%</b>	<b>-1,020</b>

## VI. Alternatives

The primary element of the Proposed Amendments to the Cap-and-Trade Regulation is removing allowances from future Program allowance budgets to reflect the GHG emissions reductions needed to meet State targets for 2030 and 2045 and align with the latest AB 32 GHG Inventory. While the statutory targets for 2030 and 2045 are to reduce State GHG emissions by 40% and 85% relative to 1990 levels, the Proposed Amendments put forth future allowance budgets that reflect a 48% reduction target for 2030, in accordance with 2022 Scoping Plan Update modeling showing the need to accelerate the pace of reductions by 2030 to meet 2045 targets. However, a range of future Cap-and-Trade Program allowance budgets may be viable for meeting the statutory GHG emissions reduction targets. For this analysis, staff specifically considered two possible alternatives for revised allowance budgets, which were informed by stakeholder input and prior analysis from the 2022 Scoping Plan Update: a scenario supporting a 40% GHG emissions reduction target for 2030 reflecting the latest AB 32 GHG Inventory, and a scenario supporting a 55% GHG emissions reduction target for 2030. Both alternatives (as well as the Proposed Scenario) include post-2030 allowance budgets that support achieving an 85% GHG emissions reduction target by 2045.

### D. Alternative 1

Alternative 1 removes 118 million allowances from the pool of pre-2030 Program allowances reserved for cost containment to support meeting the statutory target to reduce GHG emissions by 40% by 2030 relative to 1990 levels. This total amount is to align the supply of allowances for this decade with the updated AB 32 GHG Inventory. After 2030, Alternative 1 includes new allowance budgets that decline linearly to support achieving the statutory target to reduce GHG emissions by 85% by 2045 relative to 1990 levels. Tables comparing the expected costs and benefits under each evaluated scenario are included in Appendix A.

#### Costs

Like the Proposed Scenario, the costs for Alternative 1 are higher than the Baseline Scenario as a result of removing allowances from total Program supply. Since the Proposed Scenarios removes more allowances, compliance costs are higher for the Proposed Scenarios than for

Alternative 1 (i.e., Alternative 1 is a lower-cost alternative). Cost differences from differing allowances removals are reflected in the downstream effects on allowance prices and total covered emissions. Since Alternative 1 reaches a 40% GHG reduction relative to 1990 levels by 2030 (versus 48% for the Proposed Scenarios), cumulative covered emissions and allowance sales are higher for Alternative 1 (Appendix A, Table 49). However, since Alternative 1 removes fewer allowances from future budgets (i.e., total allowance supply is higher), staff analysis assumes a somewhat lower average future allowance price than under the Proposed Scenarios (Appendix A, Table 50). While the covered emissions and allowance price inputs for Alternative 1 have opposite effects on total projected Program compliance costs, the net result is lower future compliance costs than under the Proposed Scenario. And since Alternative 1 achieves fewer cumulative GHG emissions reductions, it also shows lower GHG abatement costs (Appendix A, Table 48).

Table 33. Statewide Costs of Alternative 1 (Billion 2022\$)

Year	Energy Sectors (Electricity, Natural Gas, Transportation Fuels)		Industrial Sectors (Manufacturing, Oil & Gas Production, Refineries)		Energy Cost Savings (All Sectors)	Hydrogen Incentives (IRA)	Total Cost	Total Cost-Savings	Net Costs
	Program Compliance	Abatement Attributed to the Program	Program Compliance	Abatement Attributed to the Program					
2025	\$3,067	\$676	-\$567	\$49	-\$686	-\$7	\$3,792	-\$1,260	\$2,531
2026	\$2,913	\$673	-\$539	\$74	-\$675	-\$16	\$3,661	-\$1,230	\$2,431
2027	\$2,760	\$663	-\$511	\$85	-\$658	-\$22	\$3,507	-\$1,191	\$2,317
2028	\$2,607	\$558	-\$482	\$218	-\$686	-\$47	\$3,383	-\$1,215	\$2,169
2029	\$2,453	\$279	-\$454	\$215	-\$685	-\$60	\$2,948	-\$1,199	\$1,749
2030	\$2,300	\$301	-\$426	\$255	-\$686	-\$74	\$2,856	-\$1,186	\$1,670
2031	\$2,038	\$423	-\$440	\$293	-\$639	-\$83	\$2,753	-\$1,162	\$1,591
2032	\$1,819	\$421	-\$449	\$349	-\$602	-\$92	\$2,588	-\$1,142	\$1,446
2033	\$1,600	\$411	-\$457	\$410	-\$565	-\$101	\$2,420	-\$1,122	\$1,298
2034	\$1,381	\$413	-\$465	\$454	-\$528	-\$109	\$2,248	-\$1,102	\$1,146
2035	\$1,162	\$407	-\$473	\$503	-\$490	-\$117	\$2,072	-\$1,080	\$991
2036	\$943	\$581	-\$481	\$551	-\$452	-\$126	\$2,075	-\$1,059	\$1,016
2037	\$724	\$578	-\$489	\$580	-\$415	-\$134	\$1,882	-\$1,038	\$844
2038	\$505	\$570	-\$498	\$610	-\$376	-\$142	\$1,685	-\$1,016	\$669
2039	\$286	\$572	-\$506	\$2,321	-\$474	-\$173	\$3,178	-\$1,152	\$2,026
2040	\$67	\$611	-\$514	\$3,417	-\$627	-\$213	\$4,094	-\$1,354	\$2,740
2041	-\$152	\$627	-\$522	\$3,872	-\$782	-\$252	\$4,499	-\$1,708	\$2,792
2042	-\$371	\$637	-\$530	\$4,465	-\$951	-\$292	\$5,102	-\$2,145	\$2,957
2043	-\$590	\$656	-\$538	\$4,537	-\$1,103	-\$331	\$5,194	-\$2,562	\$2,631
2044	-\$809	\$664	-\$546	\$4,731	-\$1,254	-\$369	\$5,395	-\$2,978	\$2,417
2045	-\$1,028	\$745	-\$555	\$5,494	-\$1,440	-\$411	\$6,240	-\$3,434	\$2,806
2046	-\$1,028	\$773	-\$555	\$3,071	-\$1,421	-\$402	\$3,844	-\$3,406	\$437
<b>Total</b>	<b>\$22,640</b>	<b>\$12,240</b>	<b>-\$10,997</b>	<b>\$36,555</b>	<b>-\$16,194</b>	<b>-\$3,571</b>	<b>\$75,415</b>	<b>-\$34,742</b>	<b>\$40,673</b>

## Benefits

The primary benefit of Alternative 1, relative to the Baseline Scenario, is lower cumulative GHG emissions. Both the Baseline Scenario and Alternative 1 have allowance budgets that are tied to a 40% reduction below 1990 levels by 2030, but Alternative 1 is more stringent due to alignment of allowance budgets with the recent GHG Emission Inventory adjustment, and staff analysis of Alternative 1 shows additional GHG reductions from removing 118 million allowances. Alternative 1 also achieves additional GHG reductions relative to the Baseline Scenario due to post-2030 budgets that decline linearly to reach the 2045 target.

Like the Proposed Scenarios, reductions in GHG emissions in Alternative 1 lead to reductions in criteria pollutant emissions due to the reduced combustion of fossil fuels in sectors covered by the Cap-and-Trade Program. However, Alternative 1 removes fewer total allowances than the Proposed Scenarios and thus produces less overall GHG and criteria pollutant emissions benefits (Appendix A, Table 41, Table 42, and Table 43). Alternative 1 also generates less GGRF revenues and utility allocated allowance proceeds than the Proposed Scenarios, which lowers funding available to achieve additional GHG and criteria pollutant emissions reductions, protect ratepayers, and benefit priority populations.

Staff used the methods described in Section II.D. to estimate avoided health incidents that would result from implementing Alternative 1 relative to the Baseline Scenario. The results are presented in Appendix A, Table 46 for each California air basin.

Table 34 presents the valuation of the health benefits of Alternative 1. The statewide valuation of health benefits during 2025-2046 is estimated to be \$42 billion, with approximately \$41 billion resulting from reduced premature cardiopulmonary mortality. Relative to the Proposed Amendments, Alternative 1 achieves approximately \$31 billion less in monetized health benefits during 2025-2046.



Table 34: Avoided Incidents and Valuation of Statewide Health Benefits under Alternative 1 Relative to the Baseline Scenario

Year	Cardiopulmonary Mortality	Hospitalizations for Parkinson's Disease	Respiratory ED Visits	Hospitalizations for Alzheimer's Disease	Hospitalizations for Cardiovascular Disease	Cardiovascular ED Visits	ER visits, respiratory	Asthma Onset	Asthma Symptoms	Lung Cancer Incidence	Acute Myocardial Infarction	Work Loss Days	Valuation (Million 2022\$)
<b>2026</b>	16	2	0	6	3	4	12	43	3,770	1	1	2,578	\$229
<b>2030</b>	13	1	0	5	2	3	9	33	2,818	1	1	2,025	\$189
<b>2034</b>	135	10	4	62	27	36	84	325	26,264	10	15	19,860	\$1,961
<b>2038</b>	182	13	6	87	38	48	110	424	34,397	14	20	26,164	\$2,689
<b>2042</b>	201	14	6	97	42	52	119	454	37,536	15	22	28,272	\$3,029
<b>2046</b>	211	15	7	102	45	54	122	458	38,144	16	23	29,008	\$3,245
<b>Total</b>	<b>2,829</b>	<b>204</b>	<b>87</b>	<b>1,329</b>	<b>580</b>	<b>733</b>	<b>1,706</b>	<b>6,535</b>	<b>538,272</b>	<b>213</b>	<b>308</b>	<b>404,106</b>	<b>\$42,037</b>

### Economic Impacts

The macroeconomic impact analysis results shown in Table 35 indicate that Alternative 1 would result in similar impacts on employment and output as the Proposed Scenarios but with a smaller magnitude due to the less stringent allowance budgets. Alternative 1 is estimated to result in an increase in GSP, output, and employment by 2035. These economic indicators then begin trending downwards by 2040. Figure 10 and Figure 11 show the job and economic impact changes of Alternative 1 relative to total California jobs and economic output, respectively.

Table 35. Summary of Macroeconomic Impacts of Alternative 1 Relative to the Baseline Scenario

Year	GSP		Personal Income		Employment		Output		Private Investment	
	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ Jobs	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)
2026	-0.05%	-1,645	-0.04%	-1,208	-0.05%	-12,475	-0.05%	-2,863	-0.12%	-620
2030	-0.01%	-275	-0.01%	-466	-0.01%	-3,107	-0.01%	-464	-0.02%	-120
2034	0.01%	447	0.00%	77	0.01%	1,343	0.01%	853	0.03%	221
2038	0.02%	868	0.01%	475	0.01%	3,341	0.02%	1,657	0.04%	292
2042	-0.07%	-3,445	-0.12%	-4,978	-0.08%	-22,485	-0.08%	-6,659	-0.22%	-1,588
2046	-0.02%	-1,220	-0.04%	-1,671	-0.03%	-7,409	-0.03%	-2,793	-0.01%	-108
<b>Annual Average</b>	<b>-0.02%</b>	<b>-1,108</b>	<b>-0.04%</b>	<b>-1,693</b>	<b>-0.03%</b>	<b>-8,377</b>	<b>-0.03%</b>	<b>-2,109</b>	<b>-0.06%</b>	<b>-433</b>

Figure 10. Job Impacts by Major Sector for Alternative 1 Relative to the Baseline Scenario

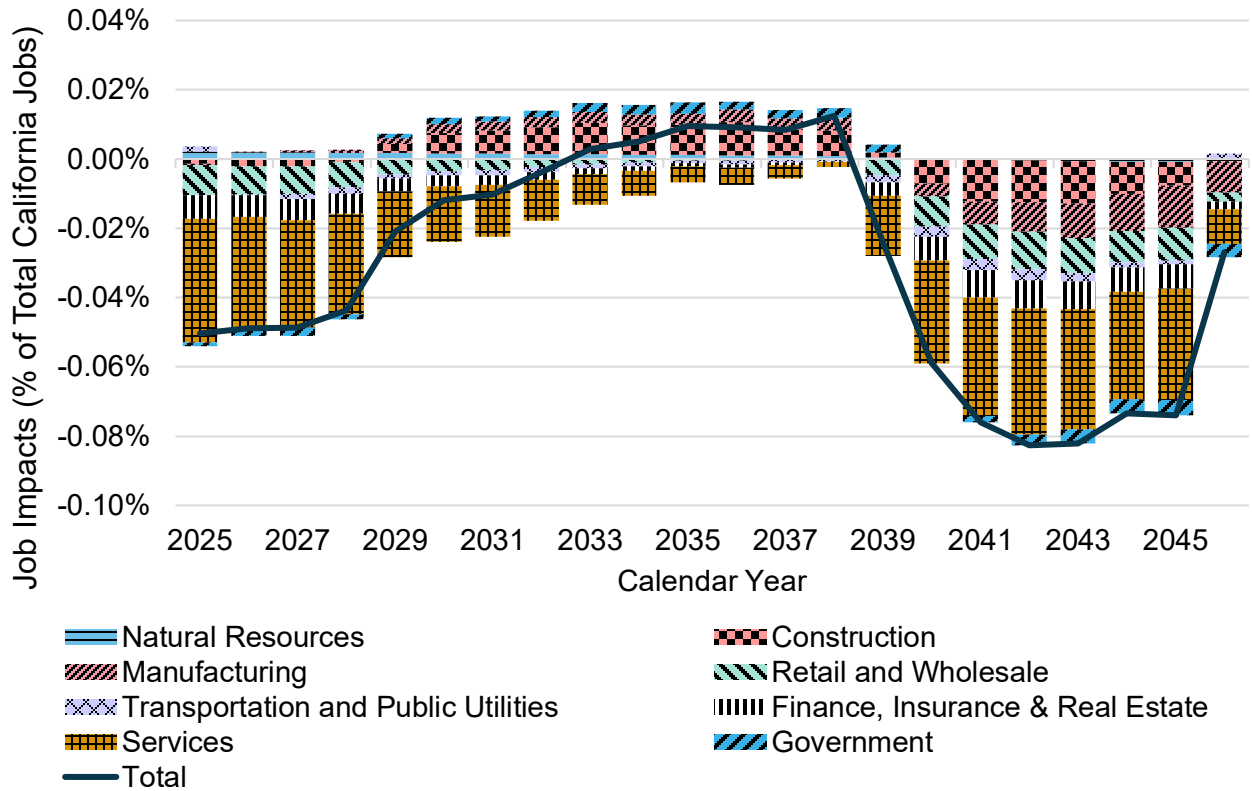
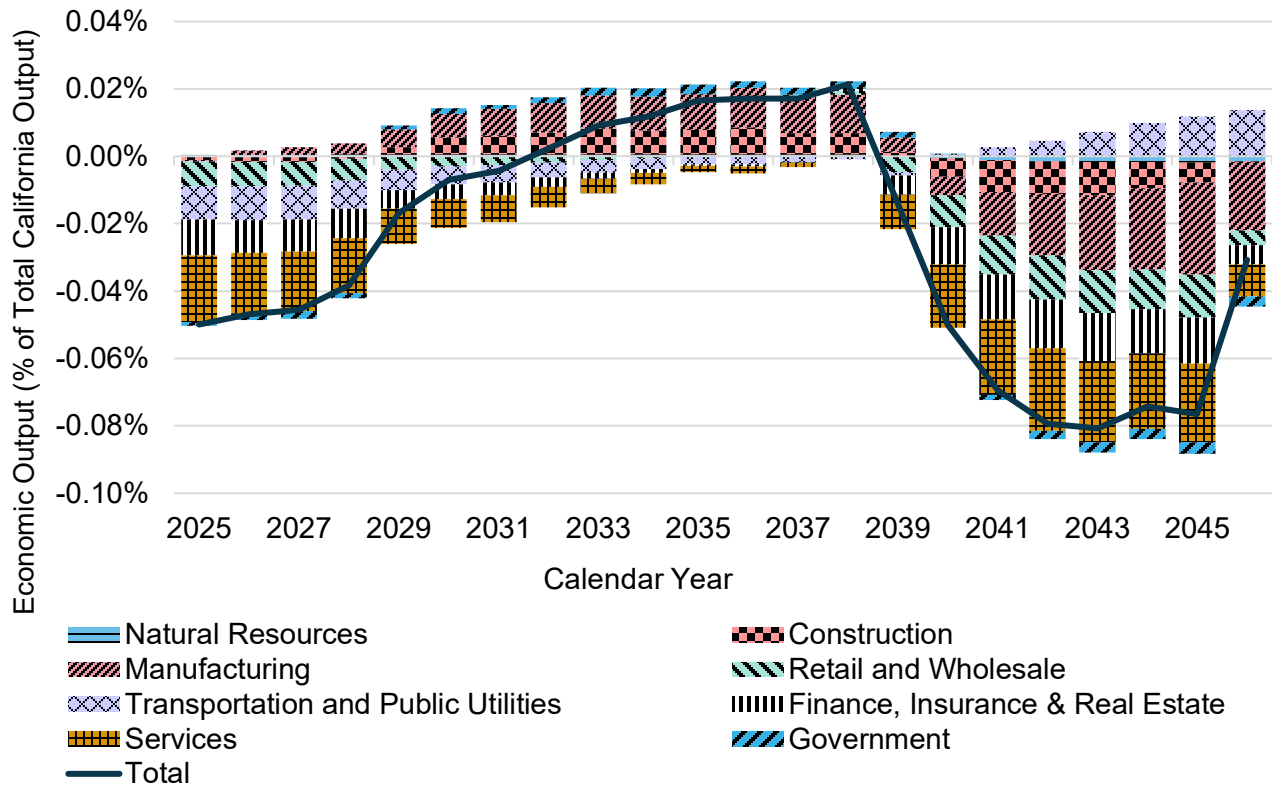


Figure 11. Change in Output by Major Sector for Alternative 1 Relative to the Baseline Scenario



### Cost-Effectiveness

Since the Cap-and-Trade Program reduces both GHG emissions and criteria pollutant emissions, staff converted all expected emissions reductions into a dollar figure equivalent in order to calculate macroeconomic impacts and make a fair comparison between scenarios (see the Macroeconomic Impacts section). In total, Alternative 1 produces an estimated \$77 billion of economy-wide benefits and imposes net direct costs of \$65 billion, relative to the Baseline Scenario during 2025-2046. In comparison, the Proposed Scenarios are estimated to produce \$135 billion in benefits and \$122 billion of net direct costs.

Table 36. Summary of Cost, Benefits, and Cost-Effectiveness of Alternative 1

Benefit and Cost Measures	Proposed Scenarios (Billion 2022\$)	Alternative 1 (Billion 2022\$)
<b>Total Costs less Transfers</b>	<b>121.9</b>	<b>64.8</b>
Total Costs	142.5	75.4
Transfers	20.6	10.6
<b>Total Benefits</b>	<b>135.0</b>	<b>76.8</b>
Total Costs-Savings	62.0	34.7
Health Benefits	73.0	42.0
<b>Summary with Social Cost of Carbon</b>		
Social Cost of Carbon	28 – 460	19 – 301.8
Net-Benefit	41.0 – 473.0	30.9 – 313.7
<b>Cost-Effectiveness</b>		
GHG Emission Reductions (MMTCO <sub>2</sub> e)	981.0	626.1
GHG Cost-Effectiveness (\$/MTCO <sub>2</sub> e)	61	48

### Reason for Rejecting

Staff rejects Alternative 1 because, while it meets the 40% GHG emissions reduction target for 2030, it is not aligned with the 2022 Scoping Plan Update modeling that suggests additional reductions are needed before 2030 to be on a course with a high likelihood of meeting 2045 statutory targets. The additional allowance removals included in the Proposed Scenarios accelerate pre-2030 GHG emissions reductions. The Proposed Scenarios provide critical near-term climate benefits and ultimately a smoother transition to the GHG emissions reductions needed to meet statutory targets and carbon neutrality in 2045.

### E. Alternative 2

Alternative 2 removes 390 million allowances from current 2025-2030 budgets to support meeting a 55% reduction in GHG emissions relative to 1990 levels by 2030. This scenario represents an upper bound on ambition for GHG emissions reductions by 2030. After 2030, Alternative 2 includes new allowance budgets that decline linearly to reach the 85% GHG emissions reduction target in 2045. Tables comparing the expected costs and benefits under each evaluated scenario are included in Appendix A.

#### Costs

Like the Proposed Scenario, the costs of Alternative 2 are higher than the Baseline Scenario as a result of removing allowances from future Program budgets. Since the Proposed Scenarios remove fewer allowances, compliance costs are lower for the Proposed Scenarios than for Alternative 2 (i.e., Alternative 2 is a higher-cost alternative). Cost differences from differing allowances removals are reflected in the downstream effects on allowance prices and total covered emissions. Since Alternative 2 reaches a 55% GHG reduction relative to 1990 levels by 2030 (versus 48% for the Proposed Scenario), cumulative covered emissions and allowance sales from 2025-2046 are lower for Alternative 2 (Appendix A, Table 49). However, since Alternative 2 removes more allowances from future budgets (i.e., total allowance supply

is lower), staff analysis assumes a somewhat higher average future allowance price than under the Proposed Scenarios to reflect a more stringent Program (Appendix A, Table 50).<sup>54</sup> While the covered emissions and allowance price inputs for Alternative 2 have opposite effects on total projected Program compliance costs, the net result is higher future compliance costs than under the Proposed Scenario. And since Alternative 2 achieves more cumulative GHG emissions reductions, it also shows higher GHG abatement costs (Appendix A, Table 48).

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<sup>54</sup> As with the Proposed Scenarios, the relationship between allowance prices and allowance demand is linked. In the near term, increased Program stringency puts upward pressure on allowance prices. Higher allowance prices then incentivize additional investment in GHG abatement measures, which in turn lowers demand for allowances. Cumulatively across 2025-2046, the result of this dynamic is that more stringent scenarios show higher average allowance prices and fewer allowances sold.

Table 37. Statewide Costs of Alternative 2 (Billion 2022\$)

Year	Energy Sectors (Electricity, Natural Gas, Transportation Fuels)		Industrial Sectors (Manufacturing, Oil & Gas Production, Refineries)		Energy Cost Savings (All Sectors)	Hydrogen Incentives (IRA)	Total Cost	Total Cost-Savings	Net Costs
	Program Compliance	Abatement Attributed to the Program	Program Compliance	Abatement Attributed to the Program					
2025	\$10,054	\$6,611	-\$1,311	\$3,326	-\$7,394	-\$37	\$19,991	-\$8,743	\$11,248
2026	\$8,110	\$6,421	-\$1,299	\$3,886	-\$7,359	-\$74	\$18,418	-\$8,732	\$9,686
2027	\$6,485	\$6,351	-\$1,275	\$4,424	-\$7,461	-\$107	\$17,260	-\$8,843	\$8,417
2028	\$5,126	\$4,696	-\$1,242	\$5,809	-\$7,535	-\$186	\$15,632	-\$8,962	\$6,670
2029	\$4,006	\$1,188	-\$1,199	\$6,201	-\$7,661	-\$233	\$11,395	-\$9,093	\$2,301
2030	\$3,083	\$1,343	-\$1,149	\$7,526	-\$7,991	-\$284	\$11,952	-\$9,424	\$2,528
2031	\$5,201	-\$1,333	-\$1,028	\$4,171	-\$2,620	-\$292	\$9,372	-\$5,273	\$4,099
2032	\$4,826	-\$1,300	-\$1,000	\$4,192	-\$2,582	-\$299	\$9,018	-\$5,181	\$3,838
2033	\$4,452	-\$1,725	-\$971	\$5,630	-\$2,679	-\$312	\$10,082	-\$5,687	\$4,394
2034	\$4,078	-\$1,222	-\$943	\$4,383	-\$2,603	-\$319	\$8,460	-\$5,086	\$3,374
2035	\$3,703	-\$1,191	-\$915	\$4,396	-\$2,564	-\$325	\$8,100	-\$4,995	\$3,105
2036	\$3,329	\$1,057	-\$886	\$4,410	-\$2,525	-\$332	\$8,796	-\$3,743	\$5,053
2037	\$2,955	\$1,034	-\$858	\$4,404	-\$2,486	-\$338	\$8,393	-\$3,682	\$4,711
2038	\$2,580	\$1,056	-\$830	\$4,399	-\$2,446	-\$345	\$8,036	-\$3,621	\$4,415
2039	\$2,206	\$941	-\$802	\$4,472	-\$2,412	-\$351	\$7,618	-\$3,565	\$4,053
2040	\$1,832	\$1,100	-\$773	\$4,377	-\$2,369	-\$357	\$7,309	-\$3,499	\$3,810
2041	\$1,457	\$1,120	-\$745	\$4,296	-\$2,326	-\$362	\$6,873	-\$3,433	\$3,440
2042	\$1,083	\$1,036	-\$717	\$4,208	-\$2,288	-\$367	\$6,328	-\$3,372	\$2,956
2043	\$709	\$1,140	-\$688	\$3,890	-\$2,244	-\$372	\$5,739	-\$3,304	\$2,435
2044	\$334	\$1,139	-\$660	\$3,550	-\$2,199	-\$376	\$5,023	-\$3,235	\$1,788
2045	-\$40	\$2,007	-\$632	\$3,291	-\$2,155	-\$380	\$5,298	-\$3,207	\$2,091
2046	-\$40	\$1,923	-\$632	\$3,160	-\$2,139	-\$373	\$5,083	-\$3,185	\$1,898
<b>Total</b>	<b>\$75,529</b>	<b>\$33,393</b>	<b>-\$20,555</b>	<b>\$98,402</b>	<b>-\$84,037</b>	<b>-\$6,421</b>	<b>\$214,175</b>	<b>-\$117,864</b>	<b>\$96,311</b>

## Benefits

The primary benefit of Alternative 2, relative to the Baseline Scenario, is lower cumulative GHG emissions corresponding to the number of allowances removed from future budgets. Since Alternative 2 reflects a more ambitious 2030 target, the GHG benefits from removing 390 million allowances from 2025-2030 budgets begin to accrue on an accelerated timeline in sectors covered by the Program. Alternative 2 also achieves additional GHG reductions, relative to the Baseline, due to post-2030 budgets that decline linearly to reach the 2045 target. While Alternative 2, Alternative 1, and the Proposed Scenarios all reach the 2045 targets, Alternative 2 achieves a greater portion of the GHG emissions reductions needed to meet the 2045 targets in earlier years. The timing of reductions in Alternative 2 results in greater cumulative emissions reductions than in the other scenarios and has implications for abatement costs. For industrial facilities, earlier investments in abatement may mean higher cumulative abatement costs due to the energy cost difference between fossil natural gas and low-carbon alternatives. However, for electricity generation, earlier deployment of renewable generation produces cumulative abatement cost savings due to the avoided procurement of generation from fossil natural gas.

Like the Proposed Scenario, reductions in GHG emissions in Alternative 2 lead to reductions in criteria pollutant emissions due to the reduced combustion of fossil fuels in sectors covered by the Cap-and-Trade Program. However, Alternative 2 removes more total allowances than the Proposed Scenarios and thus produces more overall GHG and criteria pollutant emissions benefits (Appendix A, Table 41 and Table 44). Alternative 2 also generates additional GGRF revenues and utility allocated allowance proceeds than the Proposed Scenarios, which increases funding available to achieve additional GHG and criteria pollutant reductions, protect ratepayers, and benefit priority populations.

Staff used the methods described in Section II.D. to estimate avoided health incidents that would result from implementing Alternative 2 relative to the Baseline Scenario. The results are presented in Appendix A, Table 47 for each California air basin.

Table 38 presents the valuation of the health benefits of Alternative 2. The statewide valuation of health benefits during 2025-2046 is estimated to be \$88 billion, with approximately \$87 billion resulting from reduced premature cardiopulmonary mortality. Relative to the Proposed Amendments, Alternative 2 achieves approximately \$15 billion more in monetized health benefits during 2025-2046.

Table 38: Avoided Incidents and Valuation of Statewide Health Benefits under Alternative 2 Relative to the Baseline Scenario

Year	Cardiopulmonary Mortality	Hospitalizations for Parkinsons Disease	Respiratory ED Visits	Hospitalizations for Alzheimer' s Disease	Hospitalizations for Cardiovascular Disease	Cardiovascular ED Visits	ER visits, respiratory	Asthma Onset	Asthma Symptoms	Lung Cancer Incidence	Acute Myocardial Infarction	Work Loss Days	Valuation (Million 2022\$)
<b>2026</b>	111	8	3	43	20	30	74	302	27,838	8	12	17,030	\$1,545
<b>2030</b>	304	20	9	132	58	82	194	773	67,878	23	34	45,351	\$4,328
<b>2034</b>	345	24	10	156	68	92	215	831	67,568	26	38	50,529	\$4,998
<b>2038</b>	320	22	10	150	65	84	195	751	61,375	24	35	46,003	\$4,730
<b>2042</b>	292	20	9	135	59	75	176	667	55,792	22	32	41,091	\$4,400
<b>2046</b>	214	15	7	103	45	54	124	465	38,677	16	23	29,407	\$3,285
<b>Total</b>	<b>6,018</b>	<b>414</b>	<b>180</b>	<b>2,715</b>	<b>1,194</b>	<b>1,584</b>	<b>3,721</b>	<b>14,436</b>	<b>1,216,050</b>	<b>448</b>	<b>660</b>	<b>872,444</b>	<b>\$88,177</b>

### Economic Impacts

The macroeconomic impact analysis results shown in Table 39 indicate that Alternative 2 would result in greater impacts on employment and output than the Proposed Scenarios due to the more stringent allowance budgets. Alternative 2 is estimated to result in a decrease in GSP, output, and employment for each year of the regulatory horizon. Figure 12 and Figure 13 show the job and economic impact changes of Alternative 2 relative to total California jobs and economic output, respectively.

Table 39. Summary of Economic Macroeconomic Impacts for Alternative 2 Relative to the Baseline Scenario

Year	GSP		Personal Income		Employment		Output		Private Investment	
	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)	% Δ	Δ Jobs	% Δ	Δ (2022M\$)	% Δ	Δ (2022M\$)
2026	-0.35%	-12,539	-0.33%	-10,450	-0.31%	-79,795	-0.36%	-22,012	-1.33%	-7,103
2030	-0.14%	-5,326	-0.20%	-6,651	-0.09%	-23,850	-0.15%	-9,778	-0.70%	-4,166
2034	-0.20%	-8,363	-0.19%	-6,830	-0.16%	-42,577	-0.21%	-14,798	-0.54%	-3,452
2038	-0.23%	-9,903	-0.23%	-8,535	-0.20%	-53,804	-0.23%	-17,450	-0.56%	-3,678
2042	-0.17%	-7,952	-0.17%	-7,025	-0.14%	-38,915	-0.17%	-14,067	-0.46%	-3,298
2046	-0.11%	-5,720	-0.11%	-4,838	-0.09%	-25,438	-0.11%	-9,991	-0.30%	-2,306
<b>Annual Average</b>	<b>-0.21%</b>	<b>-8,740</b>	<b>-0.21%</b>	<b>-7,608</b>	<b>-0.18%</b>	<b>-46,849</b>	<b>-0.21%</b>	<b>-15,436</b>	<b>-0.67%</b>	<b>-4,114</b>



Figure 12. Job Impacts by Major Sector for Alternative 2 Relative to the Baseline Scenario

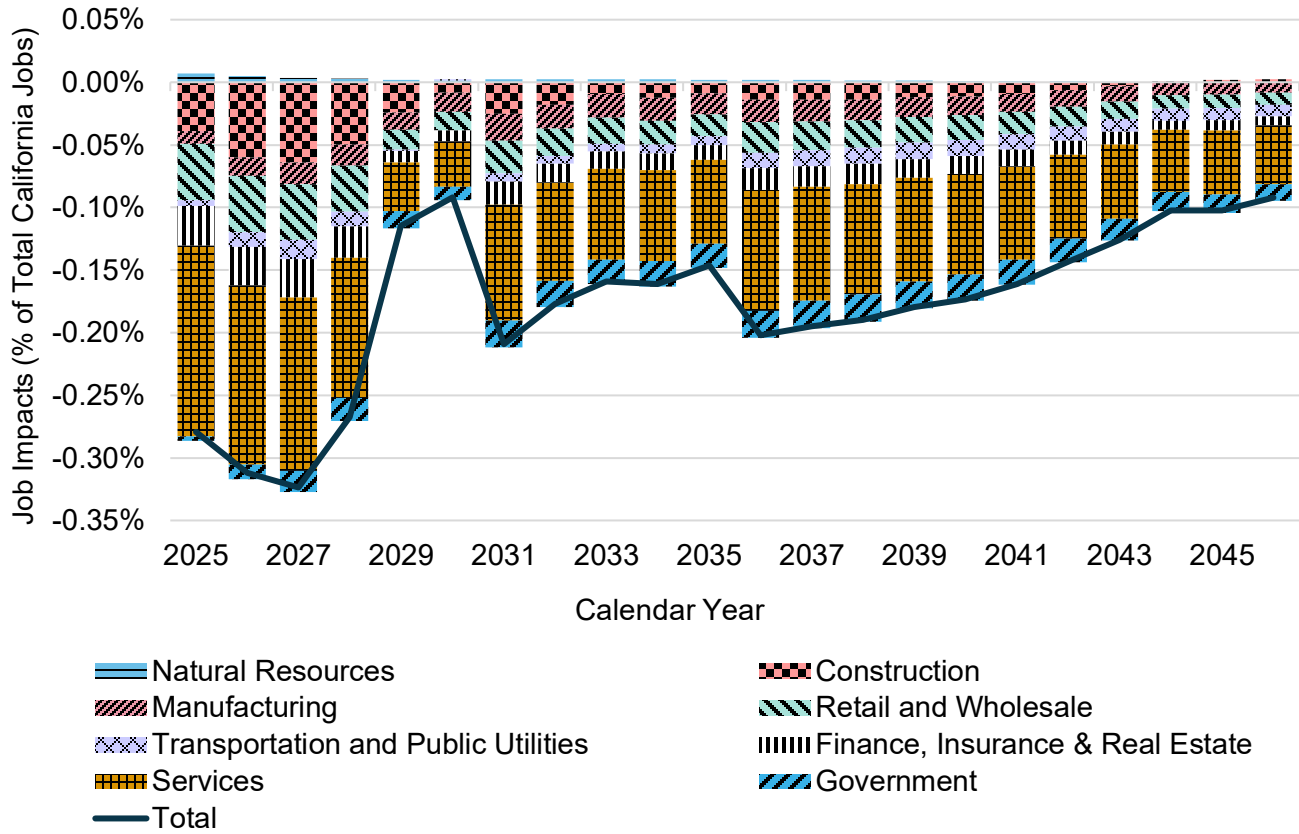
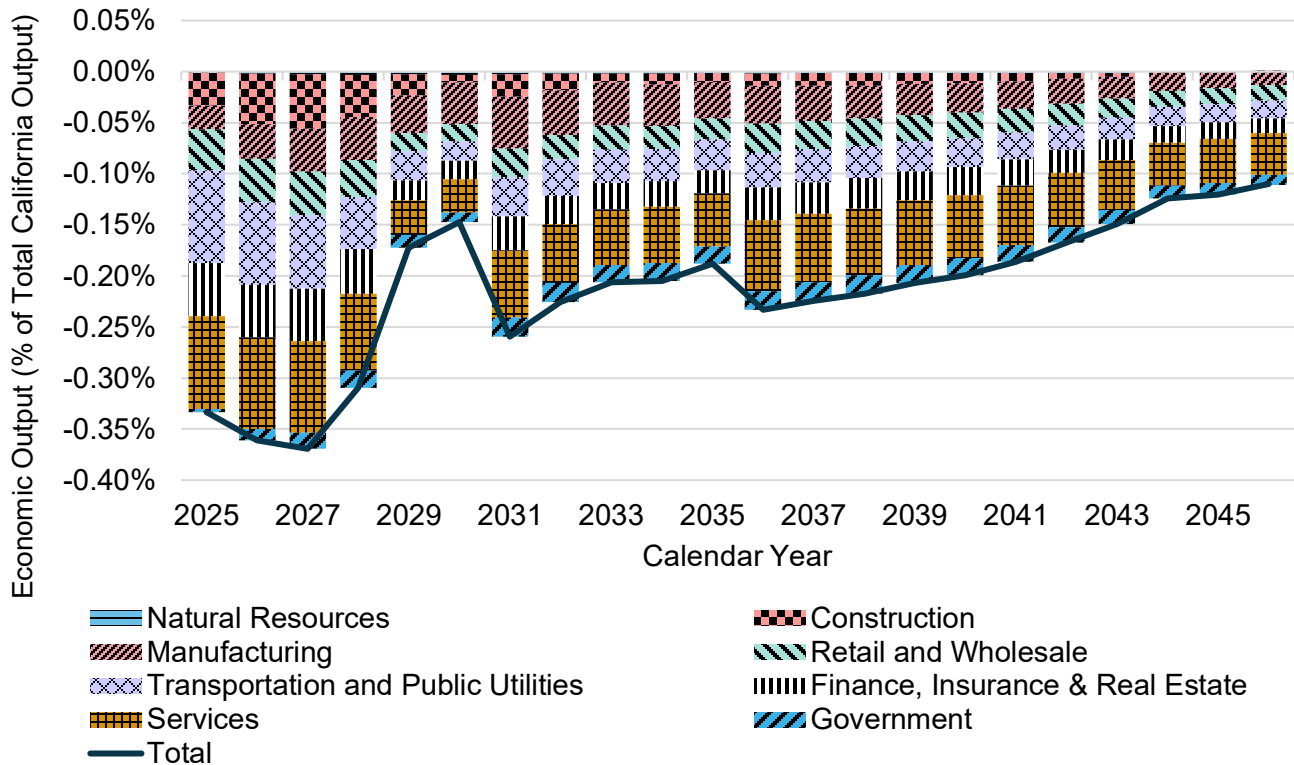


Figure 13. Change in Output by Major Sector for Alternative 2 Relative to the Baseline Scenario



### Cost-Effectiveness

Since the Cap-and-Trade Program reduces both GHG emissions and criteria pollutant emissions, staff converted all expected emissions reductions into a dollar figure equivalent in order to calculate macroeconomic impacts and make a fair comparison between scenarios (see the Macroeconomic Impacts section). In total, Alternative 2 produces an estimated \$206 billion of economy-wide benefits and imposes direct costs of \$168 billion, less transfers, on Cap-and-Trade Program covered entities, relative to the Baseline Scenario during 2025-2046. The Proposed Scenarios produce an estimated \$135 billion in benefits and \$122 billion in direct costs, less transfers.

Table 40. Summary of Cost, Benefits, and Cost-Effectiveness of Alternative 2

Benefit and Cost Measures	Proposed Scenarios (Billion 2022\$)	Alternative 2 (Billion 2022\$)
<b>Total Costs less Transfers</b>	<b>121.9</b>	<b>168.4</b>
Total Costs	142.5	214.2
Transfers	20.6	45.8
<b>Total Benefits</b>	<b>135.0</b>	<b>206.1</b>
Total Costs-Savings	62.0	117.9
Health Benefits	73.0	88.2
<b>Summary with Social Cost of Carbon</b>		
Social Cost of Carbon	28 – 460	36.3 – 606.8
Net-Benefit	41.0 – 473.0	74.0 – 644.5
<b>Cost-Effectiveness</b>		
GHG emission reductions (MMTCO <sub>2</sub> e)	981.0	1,312.4
GHG Cost-Effectiveness (\$/MTCO <sub>2</sub> e)	61	39

### Reason for Rejecting

Alternative 2 is rejected by staff because the pace of pre-2030 GHG emissions reductions may produce negative economic consequences that may be avoided while still meeting the State’s climate targets. In adopting climate regulations, AB 32 requires CARB to maintain production within the state (i.e., minimize emissions leakage) and macroeconomic analysis shows that job losses are significantly higher for Alternative 2 compared to the Proposed Scenarios (see Table 32 and Table 39). Under Alternative 2, there is a pronounced inflection point for GHG emissions in sectors covered by the Cap-and-Trade Program in 2030, after which the pace of GHG emissions reductions in these sectors considerably slows as the State approaches the 2045 targets. In contrast, the Proposed Scenarios provide some additional near-term GHG emissions benefits while also ensuring a smoother transition to meeting the GHG emissions reduction target and carbon neutrality in 2045, as shown in the 2022 Scoping Plan Update.

## Appendix A: Scenario Comparisons

Table 41: Total Projected GHG Benefits by Scenario Relative to the Baseline for 2025-2046

Category	Alternative 1 (million MTCO <sub>2</sub> e)	Proposed Scenarios (million MTCO <sub>2</sub> e)	Alternative 2 (million MTCO <sub>2</sub> e)
Increased Cap-and-Trade Program Stringency	618	967	1,285
Increased GGRF Expenditures in select Non-Regulated Sectors	8.3	11.2-16.2	27.9

Table 42: Criteria Pollutant Benefits by Year for Alternative 1 Relative to the Baseline Scenario for 2025-2046

Year	Benefits from Increased Cap-and-Trade Program Stringency (reduction in short tons of NO <sub>x</sub> )	Benefits from Increased Cap-and-Trade Program Stringency (reduction in short tons of PM <sub>2.5</sub> )
2025	-	-
2026	-	-
2027	-	-
2028	-	-
2029	-	-
2030	-	-
2031	4,370	805
2032	5,190	1,060
2033	5,900	1,310
2034	6,695	1,555
2035	7,480	1,810
2036	7,700	1,975
2037	7,980	2,105
2038	8,120	2,205
2039	8,320	2,295
2040	8,125	2,330
2041	8,910	2,290
2042	9,630	2,225
2043	10,840	2,135
2044	13,760	2,050
2045	11,985	1,945
2046	11,985	1,945
Total	136,985	30,050

Table 43: Total Criteria Pollutant Benefits by Air Basin for Alternative 1 Relative to the Baseline Scenario

Air Basin	Benefits from Increased Cap-and-Trade Program Stringency, 2025-2046 (reduction in short tons)		Benefits from Increased GGRF Expenditures in select Non-Regulated Sectors, over project lifetimes (reduction in short tons)	
	NOx	PM <sub>2.5</sub>	NOx	PM <sub>2.5</sub>
Great Basin Valleys	28	<1	1	26
Lake County	36	<1	<1	16
Lake Tahoe	88	2	<1	<1
Mojave Desert	17,185	3,740	<1	<1
Mountain Counties	209	4	8	182
North Central Coast	5,490	924	5	58
North Coast	741	82	2	39
Northeast Plateau	336	14	2	37
Sacramento Valley	7,970	1,640	7	125
Salton Sea	2,330	202	<1	(2.5)
San Diego County	3,510	767	2	<1
San Francisco Bay	24,260	6,740	3	9
San Joaquin Valley	40,375	6,860	(<1)	(<1)
South Central Coast	3,845	473	3	23
South Coast	30,585	8,600	15	2
Total	136,985	30,050	47	515

Table 44: Criteria Pollutant Benefits by Year for Alternative 2 Relative to the Baseline Scenario

<b>Year</b>	<b>Benefits from Increased Cap-and-Trade Program Stringency, 2025-2046 (reduction in short tons of NOx)</b>	<b>Benefits from Increased Cap-and-Trade Program Stringency, over project lifetimes (reduction in short tons of PM<sub>2.5</sub>)</b>
2025	3,555	570
2026	7,055	1,055
2027	10,590	1,540
2028	14,370	2,290
2029	17,990	2,845
2030	20,590	3,570
2031	22,925	4,085
2032	21,925	4,055
2033	21,015	4,030
2034	20,335	4,000
2035	19,770	3,990
2036	18,835	3,915
2037	18,225	3,805
2038	17,780	3,680
2039	17,805	3,555
2040	18,365	3,400
2041	18,595	3,145
2042	18,955	2,875
2043	19,525	2,595
2044	20,510	2,310
2045	11,985	1,945
2046	11,985	1,945
<b>Total</b>	<b>372,690</b>	<b>65,215</b>

Table 45: Total Criteria Pollutant Benefits by Air Basin for Alternative 2 Relative to the Baseline Scenario

Air Basin	Benefits from Increased Cap-and-Trade Program Stringency, 2025-2046 (reduction in short tons)		Benefits from Increased GGRF Expenditures in Non-Regulated Sectors, over project lifetimes (reduction in short tons)	
	NOx	PM <sub>2.5</sub>	NOx	PM <sub>2.5</sub>
Great Basin Valleys	155	3	4	87
Lake County	200	4	2	53
Lake Tahoe	480	9	2	<1
Mojave Desert	47,180	8,120	1	1
Mountain Counties	1,145	21	26	609
North Central Coast	18,800	2,090	15	196
North Coast	3,125	202	6	132
Northeast Plateau	1,730	49	6	132
Sacramento Valley	23,140	3,595	24	420
Salton Sea	10,585	535	2	(8)
San Diego County	9,580	1,665	4	1
San Francisco Bay	46,535	14,185	11	30
San Joaquin Valley	137,240	15,505	(3)	(1)
South Central Coast	15,545	1,140	8	76
South Coast	57,250	18,080	49	6
Total	372,690	65,215	155	1725

Table 46: Avoided Mortality and Morbidity Incidents from 2025 to 2046 under Alternative 1 for total emissions (increased Program stringency + GGRF expenditures)

Air basins	Cardio-pulmonary Mortality	Hosp. for Cardio-vascular Disease	Cardio-vascular ED Visits	Acute Myocardial Infarction	Hosp. for Resp. Disease	Resp. ED Visits	Lung Cancer Incidence	Asthma Onset	Asthma Symptoms	Work Loss Days	Hosp. for Alz. Disease	Hosp. for Park. Disease
GBV	7 (4 – 10)	1 (0 – 1)	2 (-1 – 4)	0 (0 – 1)	0 (0 – 0)	6 (1 – 10)	1 (0 – 1)	15 (15 – 16)	1,420 (-690 – 3,440)	1,005 (850 – 1,160)	3 (2 – 3)	1 (0 – 1)
LC	4 (2 – 5)	0 (0 – 0)	1 (0 – 2)	0 (0 – 0)	0 (0 – 0)	4 (1 – 8)	0 (0 – 0)	9 (9 – 10)	765 (-370 – 1,860)	475 (400 – 550)	1 (1 – 1)	0 (0 – 0)
LT	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	11 (-5 – 30)	8 (7 – 9)	0 (0 – 0)	0 (0 – 0)
MD	70 (40 – 105)	10 (9 – 15)	20 (-8 – 50)	9 (3 – 20)	2 (0 – 3)	40 (8 – 85)	5 (1 – 8)	150 (145 – 160)	12,600 (-6,135 – 30,590)	8,470 (7,140 – 9,750)	25 (20 – 30)	4 (2 – 5)
MC	65 (35 – 90)	10 (7 – 15)	15 (-5 – 30)	3 (1 – 7)	2 (0 – 4)	45 (9 – 90)	6 (2 – 9)	150 (140 – 150)	12,310 (-5,995 – 29,920)	9,675 (8,155 – 11,150)	30 (20 – 35)	8 (4 – 10)
NCC	40 (25 – 60)	9 (6 – 10)	10 (-4 – 25)	4 (1 – 10)	1 (0 – 3)	35 (7 – 75)	4 (1 – 7)	140 (135 – 150)	12,400 (-6,040 – 30,135)	8,130 (6,850 – 9,360)	15 (10 – 20)	4 (2 – 6)
NC	20 (10 – 30)	4 (3 – 5)	5 (-2 – 10)	1 (0 – 4)	1 (0 – 1)	15 (3 – 30)	2 (0 – 3)	45 (40 – 45)	3,610 (-1,760 – 8,785)	3,010 (2,540 – 3,465)	7 (5 – 8)	2 (1 – 3)
NP	4 (2 – 5)	1 (0 – 1)	1 (0 – 2)	0 (0 – 0)	0 (0 – 0)	3 (1 – 6)	0 (0 – 0)	8 (7 – 8)	610 (-295 – 1480)	480 (405 – 550)	1 (1 – 1)	0 (0 – 0)
SV	130 (70 – 180)	25 (20 – 30)	30 (-10 – 75)	15 (6 – 40)	3 (0 – 6)	80 (15 – 165)	9 (3 – 15)	325 (310 – 340)	27,000 (-13,150 – 65,590)	19,070 (16,070 – 21,950)	30 (25 – 40)	9 (5 – 10)
SS	5 (3 – 8)	1 (1 – 1)	2 (-1 – 4)	1 (0 – 1)	0 (0 – 0)	5 (1 – 10)	0 (0 – 1)	14 (14 – 15)	1,210 (-590 – 2,940)	855 (720 – 980)	2 (1 – 2)	0 (0 – 1)
SD	55 (30 – 80)	15 (10 – 20)	15 (-6 – 35)	6 (2 – 15)	2 (0 – 3)	30 (5 – 55)	5 (1 – 8)	140 (130 – 140)	11,160 (-5,440 – 27,100)	8,940 (7,535 – 10,285)	40 (30 – 50)	4 (2 – 6)
SFB	380 (210 – 540)	100 (70 – 130)	101 (-40 – 235)	45 (20 – 120)	13 (0 – 25)	250 (50 – 525)	40 (10 – 60)	990 (950 – 1025)	81,240 (-39,575 – 197,350)	65,490 (55,210 – 75,380)	220 (165 – 270)	40 (20 – 60)
SJV	485 (270 – 690)	75 (55 – 95)	125 (-50 – 290)	50 (20 – 135)	12 (0 – 20)	340 (70 – 700)	30 (9 – 50)	1,230 (1,185 – 1,280)	107,320 (-52,470 – 259,810)	66,675 (56,260 – 76,690)	170 (135 – 205)	20 (10 – 30)
SCC	30 (15 – 40)	6 (5 – 8)	7 (-3 – 15)	3 (1 – 8)	1 (0 – 2)	15 (3 – 30)	3 (1 – 4)	70 (71 – 75)	6,350 (-3,100 – 15,400)	4,500 (3,800 – 5,180)	10 (8 – 10)	2 (1 – 4)
SC	1,535 (850 – 2,195)	320 (230 – 405)	400 (-155 – 935)	170 (60 – 455)	50 (2 – 95)	840 (165 – 1,755)	110 (35 – 185)	3,250 (3,120 – 3,370)	260,280 (-126,980 – 631,370)	207,340 (174,865 – 238,590)	770 (590 – 940)	105 (55 – 150)
Statewide	2,830 (1,560 – 4,040)	580 (420 – 730)	730 (-280 – 1,710)	310 (110 – 820)	90 (3 – 170)	1,705 (335 – 3,550)	210 (65 – 350)	6,535 (6,280 – 6,780)	538,272 (-262,580 – 1,305,805)	404,105 (340,795 – 465,030)	1,330 (1,020 – 1,620)	205 (105 – 290)



Table 47: Avoided Mortality and Morbidity Incidents from 2025 to 2046 under Alternative 2 for total emissions (increased Program stringency + GGRF expenditures)

Air basins	Cardio-pulmonary Mortality	Hosp. for Cardio-vascular Disease	Cardio-vascular ED Visits	Acute Myocardial Infarction	Hosp. for Resp. Disease	Resp. ED Visits	Lung Cancer Incidence	Asthma Onset	Asthma Symptoms	Work Loss Days	Hosp. for Alz. Disease	Hosp. for Park. Disease
GBV	10 (7 – 20)	1 (1 – 1)	3 (-1 – 7)	0 (0 – 1)	0 (0 – 0)	10 (2 – 20)	1 (0 – 2)	30 (25 – 30)	2,450 (-1,195 – 5,960)	1,740 (1,470 – 2,000)	5 (3 – 6)	1 (1 – 2)
LC	6 (4 – 9)	1 (0 – 1)	1 (-1 – 3)	0 (0 – 0)	0 (0 – 0)	7 (1 – 15)	0 (0 – 1)	20 (15 – 20)	1,370 (-670 – 3,330)	850 (715 – 980)	2 (1 – 2)	1 (0 – 1)
LT	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	1 (1 – 1)	45 (-20 – 110)	30 (30 – 40)	0 (0 – 0)	0 (0 – 0)
MD	160 (90 – 230)	25 (25 – 30)	45 (-20 – 110)	20 (7 – 50)	4 (0 – 7)	90 (20 – 190)	10 (3 – 20)	345 (330 – 360)	29,110 (-14,180 – 70,700)	19,020 (16,035 – 21,890)	50 (40 – 65)	8 (4 – 10)
MC	110 (60 – 160)	20 (10 – 20)	20 (-9 – 55)	4 (2 – 10)	4 (0 – 7)	80 (15 – 160)	10 (3 – 15)	260 (250 – 270)	21,525 (-10,480 – 52,320)	16,910 (14,255 – 19,465)	50 (35 – 60)	14 (7 – 20)
NCC	90 (50 – 130)	20 (15 – 25)	25 (-9 – 60)	8 (3 – 20)	3 (0 – 6)	80 (15 – 163)	9 (3 – 15)	315 (300 – 325)	27,670 (-13,475 – 67,215)	17,800 (15,005 – 20,490)	30 (20 – 40)	9 (5 – 10)
NC	40 (20 – 60)	7 (5 – 9)	9 (-3 – 20)	2 (1 – 7)	1 (0 – 2)	30 (6 – 60)	3 (1 – 5)	80 (80 – 85)	6,745 (-3,280 – 16,400)	5,575 (4,700 – 6,420)	10 (9 – 15)	4 (2 – 5)
NP	7 (4 – 10)	1 (1 – 1)	1 (-1 – 3)	0 (0 – 1)	0 (0 – 0)	5 (1 – 10)	0 (0 – 1)	10 (10 – 15)	1,080 (-530 – 2,630)	850 (720 – 980)	2 (1 – 2)	1 (0 – 1)
SV	260 (145 – 375)	50 (40 – 65)	65 (-25 – 150)	30 (10 – 85)	6 (0 – 12)	160 (30 – 340)	20 (6 – 30)	670 (645 – 700)	55,940 (-27,250 – 135,880)	39,350 (33,170 – 45,290)	70 (50 – 80)	20 (9 – 25)
SS	20 (10 – 30)	3 (3 – 4)	5 (-2 – 15)	2 (1 – 5)	1 (0 – 1)	20 (4 – 40)	2 (0 – 3)	55 (55 – 60)	4,805 (-2,340 – 11,680)	3,240 (2,730 – 3,730)	6 (4 – 7)	1 (1 – 2)
SD	120 (70 – 175)	30 (20 – 40)	35 (-10 – 80)	13 (5 – 35)	4 (0 – 8)	60 (10 – 130)	10 (3 – 20)	330 (315 – 340)	27,870 (-13,580 – 67,670)	20,680 (17,435 – 23,800)	90 (70 – 110)	10 (5 – 15)
SFB	725 (400 – 1,040)	190 (140 – 240)	200 (-75 – 460)	90 (32 – 240)	25 (1 – 50)	490 (100 – 1,025)	70 (20 – 120)	1,960 (1,880 – 2,035)	165,140 (-80,440 – 401,180)	128,760 (108,550 – 148,215)	415 (315 – 510)	80 (40 – 115)
SJV	1,390 (770 – 1,970)	220 (160 – 275)	365 (-140 – 850)	150 (55 – 390)	35 (1 – 70)	980 (190 – 2,040)	85 (30 – 140)	3,640 (3,500 – 3,770)	321,320 (-157,180 – 777,470)	194,230 (16,3910 – 223,365)	480 (375 – 570)	65 (35 – 90)
SCC	90 (50 – 130)	20 (15 – 25)	20 (-8 – 50)	10 (4 – 25)	3 (0 – 5)	50 (9 – 100)	8 (2 – 10)	230 (220 – 235)	19,940 (-9,740 – 48,320)	13,760 (11,610 – 15,830)	30 (25 – 40)	7 (4 – 10)
SC	2,980 (1,645 – 4,250)	610 (440 – 770)	790 (-305 – 1,840)	330 (120 – 890)	95 (4 – 180)	1,660 (325 – 3,450)	220 (70 – 360)	6,500 (6,250 – 6,750)	531,030 (-259,050 – 1,288,245)	409,660 (345,485 – 471,410)	1,470 (1,130 – 1,790)	200 (105 – 285)
State-wide	6,020 (3,325 – 8,585)	1,195 (865 – 1,510)	1,585 (-610 – 3,695)	660 (240 – 1,760)	180 (7 – 345)	3,720 (730 – 7,750)	450 (140 – 730)	14,435 (13,870 – 14,980)	1,216,050 (-593,410 – 2,949,110)	872,445 (735,805 – 1,003,905)	2,715 (2,080 – 3,295)	415 (215 – 595)

Table 48: Scenario Comparison of Annual Net Direct Costs Change (Compliance and Abatement Costs) Relative to the Baseline for 2025-2046 (\$ billion)

<b>Year</b>	<b>Alternative 1</b>	<b>Proposed Scenarios</b>	<b>Alternative 2</b>
2025	\$2.5	\$5.1	\$11.2
2026	\$2.4	\$4.8	\$9.7
2027	\$2.3	\$4.5	\$8.4
2028	\$2.2	\$4.1	\$6.7
2029	\$1.7	\$3.5	\$2.3
2030	\$1.7	\$3.8	\$2.5
2031	\$1.6	\$4.0	\$4.1
2032	\$1.4	\$4.0	\$3.8
2033	\$1.3	\$4.2	\$4.4
2034	\$1.1	\$3.9	\$3.4
2035	\$1.0	\$3.9	\$3.1
2036	\$1.0	\$4.6	\$5.1
2037	\$0.8	\$4.0	\$4.7
2038	\$0.7	\$3.9	\$4.4
2039	\$2.0	\$4.2	\$4.1
2040	\$2.7	\$3.8	\$3.8
2041	\$2.8	\$3.2	\$3.4
2042	\$3.0	\$3.3	\$3.0
2043	\$2.6	\$2.5	\$2.4
2044	\$2.4	\$2.0	\$1.8
2045	\$2.8	\$2.2	\$2.1
2046	\$0.4	\$1.2	\$1.9
<b>Total</b>	<b>\$40.7</b>	<b>\$80.5</b>	<b>\$96.3</b>

Table 49: Scenario Comparison of Sector Projected Annual Emissions Obligation Relative to the Baseline Scenario for 2025-2046

2-Digit NAICS	NAICS Description	Number of Covered Facilities	2025-46 Projected Emissions Obligation (million MTCO <sub>2</sub> e)		
			Alternative 1	Proposed Scenarios	Alternative 2
21	Mining, Quarrying, and Oil and Gas Extraction	32	183	164	155
22	Utilities	156	1,181	1,151	987
31-33	Manufacturing	95	607	393	294
42	Wholesale Trade	33	989	988	988
44-45	Retail Trade	7	56	56	56
48-49	Transportation and Warehousing	8	12	11	11
52	Finance and Insurance	4	4.7	4.7	3.6
61	Educational Services	10	11	11	7.7
Others (11, 54, 55, 56, 62)	Various	8	6.7	5.8	3.7
	Total	353	3,050	2,785	2,505

Table 50: Projected Scenario Allowance Demand and Weighted Average Allowance Price, 2025-2046

<b>Scenario</b>	<b>Projected Net Allowance Demand<sup>55</sup> (billion)</b>	<b>Projected Weighted Average<sup>56</sup> Allowance Price</b>	<b>Price Assumption</b>
Baseline	2.4	\$39	Floor Price
Alternative 1	2.2	\$49	Historic (2021-2023) ratio between Floor Price and Auction Settlement Price
Proposed Scenarios	2.0	\$60	Midpoint between Floor Price and APCR 1 Price
Alternative 2	1.8	\$86	APCR 1 Price

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<sup>55</sup>Net allowance demand represents the total projected number of allowances that covered entities will need to procure (at auction or via secondary markets) to address their projected covered emissions, after subtracting current allowance holdings, free allowance allocation, and the limited use of compliance offsets. This calculation excludes any California allowances purchased for compliance obligations in the linked Québec Cap-and-Trade System.

<sup>56</sup>Average allowance prices from 2025-2046 are weighted by the total Program allowance budget in each year.

## Appendix B: Additional Technical Assumptions

### *Abatement Cost Assumptions*

CARB staff evaluated a wide variety of information sources to calculate the cost ranges for GHG abatement technologies presented in Table 16 (section III.A., GHG Emissions Abatement Costs)<sup>57</sup>:

- Staff analysis estimated a renewable natural gas price in the range \$7-\$45/MMBtu (ICF 2019).
- Carbon capture and storage costs are estimated to be in the range \$48-\$100/MTCO<sub>2</sub>e (CARB 2017, Brown et al. 2023). Staff analysis also accounts for a federal IRA CCS tax credit of \$85/MTCO<sub>2</sub>e (Congressional Research Service 2022).
- High temperature industrial heat pumps are estimated to be 3 to 5 times more expensive than electric boilers with a coefficient of performance in the range 2.2 to 3.7 (Rissman 2022). Previous CARB analysis estimated electric boilers to be approximately \$1.5M for a 110,000 lbs/hr boiler (CARB 2016, CARB 2018), placing the cost of heat pumps at approximately \$4.5M to \$7.5M for a unit of similar sized.
- Concentrated solar thermal systems have a system cost in the range of \$965 to \$1,540 per kW (Mehos et al. 2015). Staff analysis also used two applications for solar thermal project applications submitted to the CEC Food Production Investment Program.<sup>58</sup> One project estimated total costs to be \$3.3M, and it is expected to reduce natural gas usage by 7,500 MMBtu/year. Another project estimated total costs to be \$4.1M, and it is expected to reduce natural gas use by 6,400 MMBtu/year (Chant 2018a, Sanino 2018).
- Staff analysis estimated the cost of electrolytic hydrogen produced from renewable electricity to be between \$3.82 and \$5.20/kgH<sub>2</sub> (Burgess and Edwardes-Evans 2024).
- The category “electrification” includes equipment that electrify boilers and process heaters and excludes industrial heat pumps, which are disaggregated into a separate category. Staff used applications from the CEC Food Production Investment Program to estimate costs in the range \$2.3M to \$6.8M for these types of industrial electrification projects with the potential to reduce natural gas use by 10,500 to 35,000 MMBtu/year (Chant 2018b, O’Bannon 2019). The reviewed projects are expected to increase the electricity use by 500 to 4,000 MWh.

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<sup>57</sup> Staff analysis examines a range of known GHG abatement technology options but does not capture the full possible scope of mitigation measures that may be taken by facilities in response to increased allowance prices. A robust carbon price signal supports adoption of both the abatement technologies considered in this analysis and other possible abatement options that staff are not aware of.

<sup>58</sup> For more information see the [CEC Food Production Investment Program webpage](#).

### *Allowance Allocation Assumptions*

Allowance allocation to EDUs is designed to benefit electricity ratepayers and address the expected costs of Program compliance obligations. The Proposed Scenarios include updated EDU allowance allocation that reflects a cleaner electricity resource mix through 2030, in line with the SB 100 RPS target of 60% renewable electricity by 2030. To calculate expected Program compliance costs under the Proposed Scenarios after 2030, staff analysis assumes a 2045 renewable electricity target that matches 2022 Scoping Plan Scenario modeling. EDU allowance allocation for 2045 is assumed to match the projected remaining electric utility covered emissions in that year, and allowance allocation for 2031-2044 declines linearly in each year from the 2030 start point to the 2045 end point. Allocation for 2046 is assumed to match 2045.

For other sectors that receive allowance allocation, post-2030 allowance allocation is assumed to follow existing methodologies, but with more stringent cap-adjustment factors that reflect the smaller post-2030 allowance budgets under the Proposed Scenarios.

## **Appendix C: Macroeconomics**

Table 51. Industry Distribution of Passed-through Energy Costs

<b>Category</b>	<b>Commodity or Industry</b>	<b>Spread Weight</b>
Consumer	Consumption Reallocation	65.23%
Business	Forestry and Logging	0.00%
Business	Fishing, hunting and trapping	0.01%
Business	Support activities for agriculture and forestry	0.01%
Business	Oil and gas extraction	0.00%
Business	Coal mining	0.00%
Business	Metal ore mining	0.01%
Business	Nonmetallic mineral mining and quarrying	0.03%
Business	Support activities for mining	0.01%
Business	Electric power generation, transmission and distribution	0.00%
Business	Natural gas distribution	0.00%
Business	Water, sewage, and other systems	0.01%
Business	Construction	0.87%
Business	Sawmills and wood preservation	0.01%
Business	Veneer, plywood, and engineered wood product manufacturing	0.01%
Business	Other wood product manufacturing	0.04%
Business	Clay product and refractory manufacturing	0.01%
Business	Glass and glass product manufacturing	0.04%
Business	Cement and concrete product manufacturing	0.06%

<b>Category</b>	<b>Commodity or Industry</b>	<b>Spread Weight</b>
Business	Lime, gypsum and other nonmetallic mineral product manufacturing	0.03%
Business	Iron and steel mills and ferroalloy manufacturing	0.05%
Business	Steel product manufacturing from purchased steel	0.01%
Business	Alumina and aluminum production and processing	0.03%
Business	Nonferrous metal (except aluminum) production and processing	0.02%
Business	Foundries	0.02%
Business	Forging and stamping	0.01%
Business	Cutlery and handtool manufacturing	0.00%
Business	Architectural and structural metals manufacturing	0.02%
Business	Boiler, tank, and shipping container manufacturing	0.01%
Business	Hardware manufacturing	0.00%
Business	Spring and wire product manufacturing	0.00%
Business	Machine shops; turned product; and screw, nut, and bolt manufacturing	0.05%
Business	Coating, engraving, heat treating, and allied activities	0.04%
Business	Other fabricated metal product manufacturing	0.02%
Business	Agriculture, construction, and mining machinery manufacturing	0.00%
Business	Industrial machinery manufacturing	0.02%
Business	Commercial and service industry machinery manufacturing, including digital camera manufacturing	0.05%
Business	Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	0.00%
Business	Metalworking machinery manufacturing	0.01%
Business	Engine, turbine, and power transmission equipment manufacturing	0.02%
Business	Other general purpose machinery manufacturing	0.02%
Business	Computer and peripheral equipment manufacturing, excluding digital camera manufacturing	0.01%
Business	Communications equipment manufacturing	0.01%
Business	Audio and video equipment manufacturing	0.00%
Business	Semiconductor and other electronic component manufacturing	0.06%
Business	Navigational, measuring, electromedical, and control instruments manufacturing	0.03%
Business	Manufacturing and reproducing magnetic and optical media	0.00%
Business	Electric lighting equipment manufacturing	0.01%

<b>Category</b>	<b>Commodity or Industry</b>	<b>Spread Weight</b>
Business	Household appliance manufacturing	0.00%
Business	Electrical equipment manufacturing	0.01%
Business	Other electrical equipment and component manufacturing	0.04%
Business	Motor vehicle manufacturing	0.03%
Business	Motor vehicle body and trailer manufacturing	0.00%
Business	Motor vehicle parts manufacturing	0.00%
Business	Aerospace product and parts manufacturing	0.03%
Business	Railroad rolling stock manufacturing	0.00%
Business	Ship and boat building	0.00%
Business	Other transportation equipment manufacturing	0.00%
Business	Household and institutional furniture and kitchen cabinet manufacturing	0.02%
Business	Office furniture (including fixtures) manufacturing; Other furniture related product manufacturing	0.01%
Business	Medical equipment and supplies manufacturing	0.09%
Business	Other miscellaneous manufacturing	0.02%
Business	Animal food manufacturing	0.01%
Business	Grain and oilseed milling	0.04%
Business	Sugar and confectionery product manufacturing	0.06%
Business	Fruit and vegetable preserving and specialty food manufacturing	0.06%
Business	Dairy product manufacturing	0.06%
Business	Animal slaughtering and processing	0.01%
Business	Seafood product preparation and packaging	0.00%
Business	Bakeries and tortilla manufacturing	0.04%
Business	Other food manufacturing	0.08%
Business	Beverage manufacturing	0.18%
Business	Tobacco manufacturing	0.01%
Business	Textile mills and textile product mills	0.05%
Business	Apparel, leather and allied product manufacturing	0.01%
Business	Pulp, paper, and paperboard mills	0.05%
Business	Converted paper product manufacturing	0.06%
Business	Printing and related support activities	0.10%
Business	Petroleum and coal products manufacturing	0.00%
Business	Basic chemical manufacturing	0.69%
Business	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing	0.20%
Business	Pesticide, fertilizer, and other agricultural chemical manufacturing	0.10%



<b>Category</b>	<b>Commodity or Industry</b>	<b>Spread Weight</b>
Business	Pharmaceutical and medicine manufacturing	0.54%
Business	Paint, coating, and adhesive manufacturing	0.05%
Business	Soap, cleaning compound, and toilet preparation manufacturing	0.16%
Business	Other chemical product and preparation manufacturing	0.07%
Business	Plastics product manufacturing	0.15%
Business	Rubber product manufacturing	0.02%
Business	Wholesale trade	0.31%
Business	Retail trade	0.54%
Business	Air transportation	7.00%
Business	Rail transportation	0.47%
Business	Water transportation	0.93%
Business	Truck transportation	9.95%
Business	Couriers and messengers	2.31%
Business	Transit and ground passenger transportation	1.85%
Business	Pipeline transportation	0.02%
Business	Scenic and sightseeing transportation and support activities for transportation	1.39%
Business	Warehousing and storage	2.68%
Business	Newspaper, periodical, book, and directory publishers	0.00%
Business	Software publishers	0.04%
Business	Motion picture, video, and sound recording industries	0.03%
Business	Data processing, hosting, related services	0.05%
Business	Other information services	0.05%
Business	Radio and television broadcasting; Cable and other subscription programming	0.01%
Business	Telecommunications	0.06%
Business	Monetary authorities, credit intermediation, and related activities	0.07%
Business	Securities, commodity contracts, funds, trusts and other financial investments and related activities	0.09%
Business	Insurance carriers	0.00%
Business	Agencies, brokerages, and other insurance related activities	0.00%
Business	Real estate	0.75%
Business	Automotive equipment rental and leasing	0.03%
Business	Consumer goods rental and general rental centers	0.00%
Business	Commercial and industrial machinery and equipment rental and leasing	0.02%
Business	Lessors of nonfinancial intangible assets (except copyrighted works)	0.00%

<b>Category</b>	<b>Commodity or Industry</b>	<b>Spread Weight</b>
Business	Legal services	0.01%
Business	Accounting, tax preparation, bookkeeping, and payroll services	0.01%
Business	Architectural, engineering, and related services	0.04%
Business	Specialized design services	0.01%
Business	Computer systems design and related services	0.03%
Business	Management, scientific, and technical consulting services	0.01%
Business	Scientific research and development services	0.06%
Business	Advertising, public relations, and related services	0.01%
Business	Other professional, scientific, and technical services	0.01%
Business	Management of companies and enterprises	0.18%
Business	Office administrative services; Facilities support services	0.01%
Business	Employment services	0.01%
Business	Business support services; Investigation and security services; Other support services	0.02%
Business	Travel arrangement and reservation services	0.00%
Business	Services to buildings and dwellings	0.07%
Business	Waste management and remediation services	0.03%
Business	Educational services; private	0.07%
Business	Offices of health practitioners	0.04%
Business	Outpatient, laboratory, and other ambulatory care services	0.04%
Business	Home health care services	0.00%
Business	Hospitals; private	0.15%
Business	Nursing and residential care facilities	0.03%
Business	Individual and family services; Community and vocational rehabilitation services	0.03%
Business	Child day care services	0.01%
Business	Performing arts companies; Promoters of events, and agents and managers	0.00%
Business	Spectator sports	0.00%
Business	Independent artists, writers, and performers	0.00%
Business	Museums, historical sites, and similar institutions	0.00%
Business	Amusement, gambling, and recreation industries	0.04%
Business	Accommodation	0.07%
Business	Food services and drinking places	0.32%
Business	Automotive repair and maintenance	0.02%
Business	Electronic and precision equipment repair and maintenance	0.00%
Business	Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	0.00%

<b>Category</b>	<b>Commodity or Industry</b>	<b>Spread Weight</b>
Business	Personal and household goods repair and maintenance	0.00%
Business	Personal care services	0.01%
Business	Death care services	0.00%
Business	Drycleaning and laundry services	0.01%
Business	Other personal services	0.01%
Business	Religious organizations; Grantmaking and giving services and social advocacy organizations	0.02%
Business	Civic, social, professional, and similar organizations	0.02%
Business	Private households	0.00%

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