2021 ANNUAL REPORT OF THE INDEPENDENT EMISSIONS MARKET ADVISORY COMMITTEE

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Introduction and Summary

With increasingly dire warnings from scientists and the growing frequency and intensity of climate-fueled disasters, the sense of urgency in addressing climate change is only escalating. California remains committed to reducing the state's greenhouse gas emissions by 40 percent below 1990 levels by 2030. The State's carbon market covers about 75 percent of total greenhouse gas emissions and plays an important role in helping the state meet its 2030 emissions limit. The market is supported by the auction price floor set at $19.70 per ton of carbon dioxide (CO_2) emissions in 2022. While the price floor is modest compared to estimates of the social cost of CO_2 emissions, it nonetheless represents a change from the historic and once-universal practice of issuing licenses for industrial activity that resulted in air pollution for free. And although most of the emission reductions thus far achieved are likely attributable to regulatory measures, the emissions cap for covered sources nonetheless boosts confidence that the economywide limit can be achieved. We believe going forward that the role of the cap-and-trade program could be strengthened to help deliver on California's 2030 emissions limit while also improving the cost-effectiveness of the state's policy strategy.

Over most of the history of the emissions market allowance prices have hovered near the price floor, which increases gradually by 5 percent per year plus inflation. However, the summer of 2021 saw a sharp departure from trend with the November auction price reaching $28.26, an increase of two-thirds over the price a year before. This increase parallels sharp increases in prices in other allowance markets including the European Union (EU) and the eastern states' Regional Greenhouse Gas Initiative. In part this might reflect expectations about declining annual allowance budgets, as well as increasing global commitments to climate action. It might also reflect the expectation of potential new trading partners: in May 2021, Washington state passed new legislation to launch an emissions trading program by 2023.

Yet another reason for the uptick in market prices is the increasing participation of noncompliance entities in the allowance market. A growing role for financial investors and speculators can increase market liquidity and boost confidence, but it also introduces new challenges for market oversight and the potential for greater price volatility.

Scoping Plan

This year the revised Scoping Plan will be a central activity for the California Air Resources Board (CARB or Board). The focus thus far in that process has been to identify long-term technological outcomes consistent with the state's goal of carbon neutrality by 2045, or even sooner. While creating a vision for long-term action is valuable and sets an important precedent, this year's Independent Emissions Market Advisory Committee (IEMAC or Committee) report emphasizes the need to also focus on policies and measures that will help the state achieve its statutory 2030 emissions limit. We encourage the agency to develop an actionable blueprint with contingencies that can be brought forward as necessary, depending on interim milestones. A more

specific examination of pathways to achieve the 2030 limit would also help illuminate the issue of affordability, who bears the cost of emissions reductions, and what improvements in air quality can be expected to accompany greenhouse gas emissions reductions. This effort should give elevated attention to outcomes that prioritize environmental improvements in historically disadvantaged and environmentally overburdened communities.

Allowance banking

The market's third compliance period (2018-2020) resulted in 100 percent compliance. This good news was also accompanied by noteworthy data that indicate a substantial number of allowances were held (or "banked") in private accounts, raising questions about the program's ability to contain emissions from sources covered by the emissions cap to adequately to support the economywide greenhouse gas limit in the years ahead. All told, some 321 million allowances were banked into the market's post-2020 period, equal to more than the emissions reductions expected from the program over the coming decade. An additional reserve supply of allowances totaling 274 million tons resides in public accounts and could also enter the market, depending on future prices. One factor contributing to the pent-up supply in private accounts could be precautionary saving in anticipation of the decreasing emissions cap; another is the role of companion policies that have successfully reduced emissions at sources covered by the cap-and-trade program and helped to achieve California's 2020 greenhouse gas reduction goals four years ahead of schedule; and another is the recent decline in economic activity associated with the pandemic. Whatever the explanatory factors, the number of allowances held in private and public accounts casts uncertainty over the state's ability to hit its 2030 emissions limit. These findings also offer an opportunity for the Air Resources Board to take stock of the program and consider adjustments to allowance supplies going forward.

Emissions market design and program reform

Adjustments to allowance supply have been made previously in response to legislative direction or to implement the goals of Assembly Bill (AB) 32 (Statutes of 2006, Chapter 488). Previous IEMAC reports have identified additional options for potential adjustments to the market if the allowance supply-demand dynamics move out of balance and risk undermining state goals. In this year's report, we outline the options with greater specificity. When evaluating additional market reforms, we express a preference for rule-based measures that automatically apply based on criteria identified in advance of observing program outcomes. One workable approach would adjust the allowance supply in response to auction outcomes, effectively enhancing the market's price floor by adding an additional emissions containment price step, as exists in other North American emissions trading programs. We also point to the impact that program reform could have on revenues to the Greenhouse Gas Reduction Fund (GGRF), which provides an important element of the state's ability to address environmental justice concerns, and we describe steps that could maintain or increase revenues to the Fund if other program reforms were implemented.

Carbon offsets

Offsets constitute a significant source (6.3%) of the supply of compliance instruments in the market, with forest offsets producing about 80% of offset supply to date. These offsets provide incentives for emission mitigation measures outside of the sectors covered by the cap-and-trade program, and they play a role in managing costs for compliance entities. At the same time, the quality and permanence of forest offsets remain important questions that continue to be debated and examined in the academic literature. This report does not provide the platform for resolving those debates, but the compilation of evidence and concern invites consideration of potential structural reforms that may enhance the contribution of emissions reductions outside the market, including from the natural and working lands sector. Potential reforms that are discussed in this report include an ex-post assessment of offset program performance to inform the retirement of allowances to account for any identified shortcomings. Offsets alternatively could be counted underneath the cap in an approach developed in Washington state, where the issuance of new allowances is expected to be reduced when offsets are certified. Because California's approach to funding climate mitigation outside of the cap-and-trade provides a model internationally, as other jurisdictions also look for ways to develop institutions and technologies that can mitigate non-fossil fuel related emissions, the continued evolution of the offsets program plays an important role not only in the state but more broadly. One of the most readily available ways to continue this transformation would be to supplement or replace the offsets program with public expenditures from the Greenhouse Gas Reduction Fund that are aimed at beneficial multi-attribute outcomes addressing emissions mitigation, ecological sustainability, and environmental justice in a coordinated manner.

Leakage

The introduction of a carbon price and other greenhouse gas regulations in California could provide incentives for economic activity and associated emissions to shift to other jurisdictions that regulate emissions less stringently – or not at all. This important concern is known as leakage, and several measures are in place to mitigate its potential impact in the California market. Recent research assesses the effectiveness of these measures. In the electricity sector, researchers document patterns of greenhouse gas emissions across the western market that are consistent with some degree of resource shuffling (a form of leakage). To help address those concerns, we recommend the Air Resources Board fully engage with other state agencies in planning for the expansion and deepening of western electricity markets. We suggest the Board could expand its practice of conducting ex post assessments of leakage and cancel allowances accordingly when leakage is evident. In contrast to findings in the electricity sector, research suggests emissions leakage associated with industrial activity has been more limited to date. Nonetheless, the concerns of firms and labor are deeply held, and will only grow in importance as California's climate policy strengthens over time. California's output-based free allocation of allowances is designed to foreclose the incentive for leakage for industrial emitters. Under the current allocation design, however, the

possibility of overly generous allocation is significant because the allocations for industry are based on old data and assumptions about prices in the allowance market. Because free allocations to industry have the opportunity cost of reduced revenue to the GGRF, the data and assumptions underpinning free allocation should be revisited by CARB.

In conclusion, the market has reached an important milestone in completing its third program period with 100 percent compliance. But the state can ask more of the emissions market, which could play a greater role in driving cost-effective outcomes and enabling greater economy wide emissions reductions than it has in the past. This year provides an opportunity as part of the Scoping Plan process for the Air Resources Board to further illuminate expectations for the market, and thereby help set course for the continuing decarbonization of California.

Climate Change Scoping Plan

Lead Authors: Katelyn Roedner Sutter, Danny Cullenward and Dallas Burtraw

Introduction

California's climate leadership is built on ambitious climate goals, but also on successfully implementing policy to deliver emission reductions to meet those goals. The Climate Change Scoping Plan, updated every five years, is a critical part of this policy implementation. The California Air Resources Board is currently in the process of developing the 2022 Scoping Plan, which if credible and actionable, could be an important global example of identifying the emission reduction policies that deliver a specified greenhouse gas reduction goal.

This chapter briefly reviews the 2017 Scoping Plan and the progress thus far on the 2022 Scoping Plan. It concludes with recommendations to ensure the current Scoping Plan is designed to maximize emission reductions in the current decade and ensure California is on track to meet longer-term climate goals.

2017 Scoping Plan

California's 2017 Scoping Plan identified pathways to achieving the state's 2030 greenhouse gas reduction goal of 40% below the 1990 level, as well as how to position the state to be on track for mid-century decarbonization. The adopted Scoping Plan finds that "enhancing and implementing these ongoing efforts [low carbon fuel standard, renewable portfolio standard, etc.], paired with a more stringent cap-and-trade program, puts California on the path to achieving the 2030 target per Senate Bill (SB) 32 (Statutes of 2006, Chapter 249) and to deliver climate, air quality, and other benefits."[1]

Specifically, the 2017 Scoping Plan estimated that known commitments from sector-specific abatement would likely account for 385 million metric tons of carbon dioxide equivalents (MMT CO_2e) in cumulative emission reductions between 2021 and 2030, or 62% of the needed abatement — leaving the cap to close the remaining gap. The cap-and-trade program covers combustion-related CO_2 emissions constituting about three-quarters of the state's total greenhouse gas emissions inventory. The Scoping Plan anticipated that the cap would be the primary driver of 236 MMT CO2e in additional cumulative reductions from 2021 to 2030 — 38% of the needed economy-wide abatement.

Since the adoption of the 2017 Scoping Plan, there has been a great deal of discussion regarding the 38% expected reductions from cap-and-trade and if that is realistic or appropriate. Either way, projecting these outcomes with certainty is extremely difficult. However, the more crucial question is if the cap is set with sufficient stringency to ensure that total greenhouse gas emissions from all sources do not exceed target

[1] https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2017-scoping-plan-documents

levels, and that the budget itself is sufficiently ambitious to drive the immediate emission reductions needed in this decade. In other words, the emissions cap must be set to ensure the state meets the 2030 greenhouse gas reduction target. A well-designed emissions limit at sources covered by the cap-and-trade program provides greater confidence of meeting the state's greenhouse gas reduction goals.[2]

Quantities *with* prices

The approach taken in the 2017 Scoping Plan clearly established the role of the cap-and-trade program as a backstop for emissions at sources covered by the trading program, and alongside sectoral policies it also enhances confidence of achieving economy-wide emission reduction goals. The cap is designed to be responsive to allowance prices; changes in the quantity of allowances can increase or decrease the role of the cap in achieving economy-wide goals.

At the same time, CARB has previously characterized the purpose of the cap-and-trade program as to create a steadily increasing price signal.[3] A well-designed quantity limit that delivers a price on carbon are powerful drivers of emission reductions. An appropriately calibrated declining cap increases the confidence of limiting greenhouse gas emissions to the levels required, such as those in law in California under SB 32, while the price on carbon can send a clear economic signal—guiding the innovation and investment necessary to achieve those reductions.

2022 Scoping Plan

The purpose of the 2022 Climate Change Scoping Plan is to assess progress toward meeting the 2030 greenhouse gas reduction goal, as well as lay out a path to carbon neutrality by 2035 or 2045, and is described by CARB as an "actionable statewide blueprint to align efforts to achieve the state's climate goals."[4] But unlike the 2017 Scoping Plan, the 2022 Scoping Plan as discussed in the planning process thus far does not evaluate abatement potential of policies nor attribute reductions to specific measures.[5] It is difficult to understand how progress toward the 2030 greenhouse gas emission reduction goal or the development of an "actionable blueprint" of state efforts can be achieved without such evaluation of existing policies.

Instead, it appears that CARB's intention is to identify technology options and subsequently choose a technology pathway, rather than identifying the potential gap

[2] The 2017 legislative extension of the cap-and-trade program under AB 398 (Statutes of 2017, Chapter 135, E. Garcia) included a price ceiling as an additional cost containment feature. If a price ceiling sale is held, CARB issues allowances sufficient to cover all compliance obligations. In order to maintain the integrity of the emissions cap despite the issuance of additional allowances, CARB is required to use the revenue from a price ceiling sale to purchase additional reductions on at least a ton-for-ton basis.
[3] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/capandtrade18/ct18398.pdf
[4] https://calepa.ca.gov/wp-content/uploads/sites/6/2021/10/2021_0928_CARB-IEMAC-Scoping-Plan-Update.a.pdf
[5] CARB staff presentation at September 28, 2021 IEMAC meeting

between expected reductions and those reductions needed to achieve the 2030 goal or a subsequent carbon neutrality goal.[6]

IEMAC understands that the Scoping Plan process is not a regulatory proceeding and that specific policies are not amended or adopted through this process. However, to ensure an "actionable blueprint" and that the state is on track to meet its climate commitments, IEMAC recommends that the Scoping Plan include an evaluation of existing policy, recommendations where existing policy could be more ambitious, and recommend what, if any, additional policy will likely be needed. Any gap between emissions projected under existing/planned policies and state level targets could in principle be closed by the cap-and-trade program, provided the cap is sufficiently stringent.

More specifically, in the previous Scoping Plan CARB made a prediction regarding the role of the cap-and-trade program in achieving the 2030 goal based on the abatement potential of sector-specific policies. No such evaluation is evident in the current Scoping Plan planning process, leaving an assessment of the role of cap-and-trade in meeting the 2030 goal absent from the Scoping Plan process. While this is a challenging exercise, a clear expectation of the role of cap-and-trade in the current decade is important for regulatory certainty and emissions planning.

Recommendations

Modeling

- IEMAC recommends that CARB establish an emissions baseline scenario by evaluating the abatement potential of all existing climate policy out to 2030, 2035, and 2045. This is the foundation for identifying additional actions the state must take to achieve the 2030 statutory goal as well as those directed by executive action.
- CARB should also consider the approximate abatement potential of the cap-and-trade program, including offsets, and specifically evaluate the required level of the emissions cap to act as a backstop for meeting climate goals. While IEMAC recognizes that any change to the program would take place through a formal rule-making process, an appropriate cap level (i.e., an appropriate allowance budget) is essential to achieving these goals and providing regulatory certainty—and thus a key input for modeling the abatement needed from other policies. IEMAC is concerned that none of the proposed Scoping Plan scenarios consider the level of the emissions cap or the rate at which it could decline.

Policy Ambition

- After CARB has established the emissions baseline based on the reductions expected from current policy including the backstop currently embodied in the

[6] https://ww2.arb.ca.gov/sites/default/files/2021-08/carb_presentation_sp_scenarioconcepts_august2021_0.pdf

cap-and-trade program, IEMAC encourages CARB to identify the sectoral policies that could be strengthened and/or where additional policy could be beneficial including potential reforms of the cap-and-trade program. IEMAC recognizes these would each require a formal regulatory process or additional legislative direction. While cap-and-trade is likely the most cost-effective means to achieving a particular greenhouse gas emissions goal as it ensures that individual entities have an incentive to pursue all available low-cost opportunities to reduce emissions, there are potentially additional benefits that would come from enhanced sectoral policies including local air quality improvements or addressing environmental equity, and CARB should consider evaluating such benefits.

- As CARB discusses cap-and-trade in the Scoping Plan, IEMAC recommends the agency be transparent in framing the goals for the program as it contributes to achieving the economywide emissions target.
- While the limit covering 75% of California's emissions is a central feature of the state's climate policy, the remaining 25% of emissions must be addressed as well. IEMAC recommends that the Scoping Plan make specific recommendations with respect to these uncovered sources, again including where existing policy could be more ambitious or where new policy is potentially beneficial.

Timeline

- As CARB identifies opportunities for greater ambition in existing policy, including cap-and-trade, and potential new policy IEMAC encourages CARB to seek to maximize cumulative emission reductions before 2030 rather than delay necessary abatement.
- The Intergovernmental Panel on Climate Change has found that the world could reach 1.5°C of warming as early as 2030.[7] As such, it is essential that California accelerate its emission reductions in the current decade. Because of the need for near-term climate ambition, IEMAC strongly encourages CARB to not wait until after the Scoping Plan is adopted in late 2022 to begin considering which climate policies need to be strengthened or newly developed. Instead, IEMAC recommends that CARB and the Legislature begin considering additional action before the Scoping Plan is finalized. At the very least, CARB could begin a process similar to what they have done with the Low Carbon Fuel Standard; identify possible program enhancements and start soliciting feedback now, so a rulemaking could start immediately upon conclusion of the Scoping Plan process and implementation could begin as early as 2024. Delayed implementation of policy adjustments would lead to greater cumulative emissions in the interim – requiring increasingly steep reductions to achieve the same emissions outcome and making it increasingly difficult to keep emissions within the necessary carbon budgets.

[7] https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf

Additional Analysis

- In addition to the economic and health analysis of the Scoping Plan scenarios already planned, IEMAC recommends that CARB consider an analysis of affordability impacts, specifically with respect to the electricity sector and rural, low-income, and historically overburdened communities. However, technology outcomes alone do not determine the distribution of costs and benefits to Californians; instead, affordability impacts depend on the policy design. To help understand "who pays," it needs to be clear which policies are being relied upon to get California to its climate goals. As such, the above recommendations to identify the emissions gap and policies to close the gap are also necessary to identify, and then prevent, disproportionate cost burdens on heavily impacted communities as California meets its climate goals.

Conclusion

To ensure that California is on track to meet its climate goals, it is important for CARB to identify the potential of existing climate policy to deliver emission reductions. IEMAC also encourages CARB to establish the necessary level of the emissions backstop embodied in the cap-and-trade program to provide the greatest possible certainty of meeting those goals. IEMAC recommends that the Scoping Plan then describe where enhanced ambition is necessary – either through increased stringency of existing policy or potential new policy. This would make the Scoping Plan not only actionable, but replicable in the future and in other jurisdictions.

A credible and actionable Scoping Plan is an important global example of identifying the emission reduction policies that deliver a specific level of greenhouse gas reductions. As such, as CARB develops the latest Scoping Plan, it is important to identify replicable climate policy and its abatement potential as well as how to close an emissions gap with the greatest possible certainty in order to meet climate targets. A Scoping Plan designed without policy is a poor example for other jurisdictions that are off track from their own climate goals because it obscures *how* to meet such goals.

Allowance Banking

Lead authors: Danny Cullenward and Meredith Fowlie

- **Summary:** Public program data indicate that private market participants have banked about 321 million allowances from the Western Climate Initiative cap-and-trade program's first three compliance periods (2013–2020) to its post-2020 phase (2021–2030). Observed allowance banking is consistent with projections from analysts who expressed concern about the stringency of program caps, and directly related to the use of nearly 159 million carbon offsets for compliance purposes. It is also larger than the total reductions CARB projected the cap-and-trade program would deliver over the coming decade in its 2017 Scoping Plan. Although a complete analysis of allowance banking outcomes is beyond the scope of this chapter, as we do not make any projections about the demand side of the market, these findings indicate a need for policymakers to evaluate whether current program caps are consistent with California's 2030 emissions limit.
- **Recommendations:** The committee's findings support two recommendations.
  1. We encourage CARB to identify expected future emissions from sources covered by the cap-and-trade program in the context of the 2022 Scoping Plan process.
  2. We encourage CARB to adopt metrics for timely evaluation of the total number of allowances in circulation (the allowance bank).

At its core, a cap-and-trade program requires a group of covered emitters to periodically surrender compliance instruments — allowances and carbon offsets, each worth one tonne (t) of carbon dioxide (CO_2) equivalent (e) (tCO_2e) — equal to their own emissions. As the supply of compliance instruments declines over time, so too must pollution. However, California's cap-and-trade program allows market participants to save (or "bank") allowances for future use. When allowance supplies in one compliance period exceed covered emissions, program participants can bank them to emit more in future compliance periods.

The main greenhouse gas, carbon dioxide, is known as a "stock" pollutant. For stock pollutants, what matters most is the cumulative total of emissions, not the rate of emissions at a particular point in time. When a cumulative emissions cap is defined and fixed over a multi-year timeframe, as is done in California's cap-and-trade program, then the allocation of an emissions budget over time does not significantly affect climate outcomes. Some flexibility is warranted, as affording regulated entities the ability to shift a cumulative budget of emissions across time via allowance banking can reduce the cost of meeting an overall emissions cap.

One challenge with this approach is that policymakers must define the overall cap at the outset of the program with only limited information about many key factors that determine expected emissions and abatement costs, such as macroeconomic

conditions and technological change (Borenstein et al. 2019; Wara 2015). A second problem arises when designing cumulative program caps to support annual emissions targets, such as California's 2030 statewide emissions limit (IEMAC 2020, Chapter 5). Striking the right balance between climate ambition and abatement cost can be challenging. If ex-ante assumptions that informed the allowance budgeting decision turn out to be incorrect, policy reforms could be warranted.

The IEMAC has previously addressed questions about allowance banking and "overallocation" pursuant to AB 398 (IEMAC 2018, Chapter 6; IEMAC 2019, Chapter 4). Legislators have also asked CARB and the IEMAC to develop "banking metrics" to track the evolution of the program's supply-demand balance (IEMAC 2019, Appendices A and B). CARB Board Resolution 18-51 provided direction to staff to prepare a report describing allowance banking outcomes at the end of the cap-and-trade program's third compliance period (2018–2020) (CARB 2018a, p. 11). To our knowledge CARB has not yet indicated its plans with respect to adopting any potential banking metrics. Meanwhile, the IEMAC illustrated how public reporting data could be used to construct banking metrics (IEMAC 2019, Appendix C) via a methodology that was subsequently peer-reviewed (Cullenward et al. 2019).

Recent compliance data provide an important opportunity to observe market outcomes and use this information to assess the stringency of current program regulations. Following the end of three-year compliance periods, covered emitters in California's and Québec's linked cap-and-trade programs are required to surrender compliance instruments equal to their historical emissions. In November 2021, both jurisdictions held compliance events for emissions from calendar years 2018 through 2020. After this compliance event — and a November 2021 quarterly auction, at which previously unsold vintage 2019 and 2020 allowances were sold to private buyers — CARB published its Q4 2021 Compliance Instrument Report, which measures market-wide compliance instrument holdings as of January 5, 2022 (CARB 2022). As a result of the timing of these events, the Q4 2021 Compliance Instrument Report effectively reports the number of allowances banked into the cap-and-trade program's post-2020 market period (IEMAC 2019, Appendix C at Table 3).

- **Finding #1:** Public program data indicate that private market participants in the Western Climate Initiative (WCI) banked about 321 million allowances from the market's first three compliance periods (2013–2020) into its post-2020 phase (2021–2030).[8] Observed allowance banking significantly exceeds the scenario considered by CARB in its 2018 cap-and-trade rulemaking process and is broadly consistent with projections from analysts who raised concerns about allowance overallocation.

[8] This number is calculated by summing entity account holdings (columns B, C, and D) of vintage 2013 through 2020 allowances (rows 14-21) and non-vintage allowances (rows 32-33) in CARB (2022).

Banking outcomes can be compared against projections made by various parties during the implementation of AB 398. In a 2018 rulemaking process, CARB analyzed a scenario in which 150 million California allowances were banked into the market's post-2020 period (CARB 2018b). In contrast, a series of reports from the Legislative Analyst's Office (LAO 2017), climate policy analyst Dr. Chris Busch (Busch 2017), and the Environmental Commissioner of Ontario (ECO 2017) generally projected higher banking outcomes and raised concerns about the extent of projected allowance banking on the program's ability to reduce post-2020 emissions in line with statutory targets (see Table 1 and Figure 1).[9] Projections are inherently uncertain; nevertheless, new compliance data provide CARB with an opportunity to review its methodology in the context of current market information.

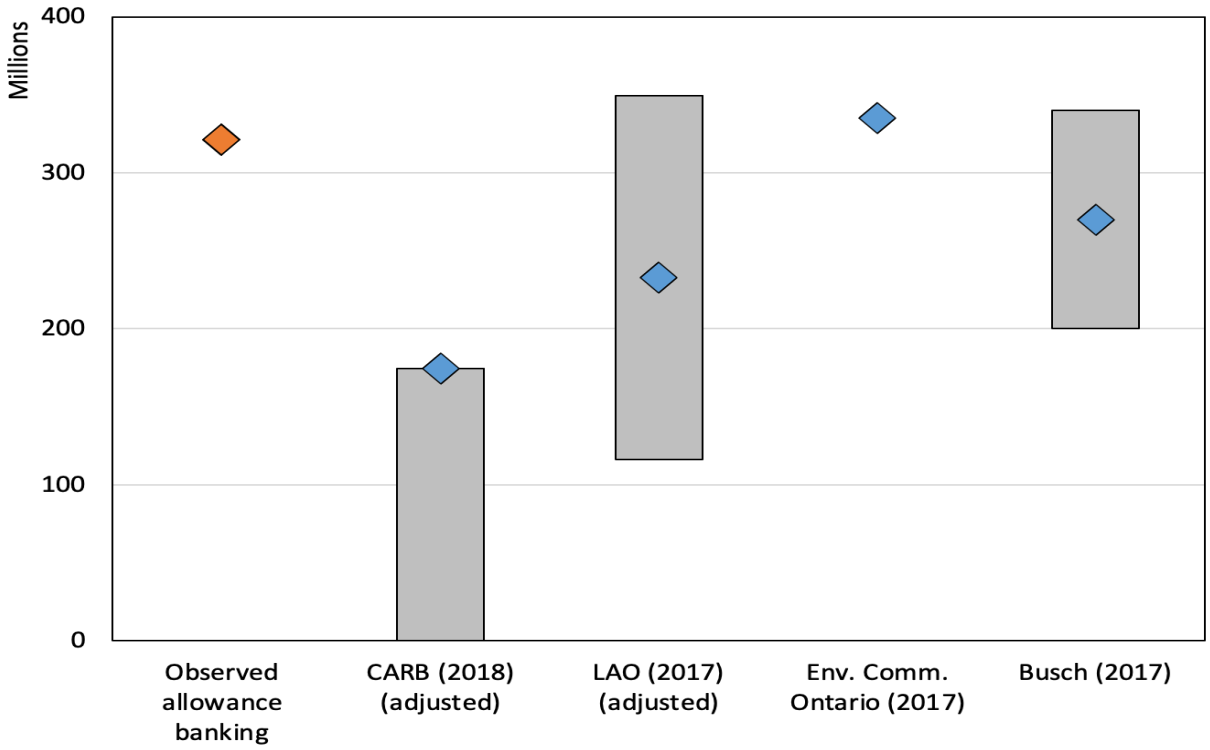
Table 1: Comparing Allowance Banking Scenarios

Source	California allowances banked	Total WCI allowances banked
Observed banking (this chapter)	N/A	321 million
CARB (2018b) [10]	150 million	175 million
LAO (2017) [10]	200 million (± 100 million)	233 million (± 116 million)
ECO (2017)	N/A	335 million
Busch (2017)	N/A	270 million (± 70 million)

[9] The calculations behind Table 1 and Figure 1 are available at https://calepa.ca.gov/wp-content/uploads/sites/6/2022/01/IEMAC-Report-allowance-banking.xlsx

[10] CARB and the LAO projected the number of California allowances banked into the market's post-2020 period, while others projected the total number of allowances irrespective of jurisdictional origin. Because public reporting data does not provide a jurisdictional breakdown by allowance origin (see IEMAC 2019, Appendices A and B), it is not possible to report observed banking of California allowances in isolation. To compare numbers on an apples-to-apples basis, we adjust projections of California-only allowance banking by 1.164, which is the ratio of (1) the sum of the 2020 allowance budgets for California (334,200,000 allowances) and Québec (54,740,000 allowances) to (2) the 2020 allowance budget for California (334,200,000 allowances). For California budgets, see Cal. Code Regs. title § 95841, Table 6-2; for Québec budgets, see Order in Council 1126-2017 (22 Nov. 2017).

Figure 1: Comparing Allowance Banking Scenarios [11]



As discussed in previous IEMAC reports, many leading climate regulators publish banking metrics to track market supply-demand dynamics, improve program transparency, and/or implement rule-based adjustments to allowance supplies (see IEMAC 2019, Chapter 4 and Appendix C). We continue to recommend that CARB adopt banking metrics going forward.

- **Finding #2:** Just under 159 million offset credits were surrendered to regulators in California and Québec in the first three compliance periods (2013–2020), contributing directly to the total private bank of 321 million allowances. Because most carbon offsets enable higher statewide emissions, their historical and future use increase the extent of in-state mitigation necessary to achieve California's 2030 statewide emissions limit.

The use of carbon offsets has important effects on the extent of allowance banking as well as the location of emissions and emission reductions. Both factors increase the amount of in-state mitigation required to meet California's climate targets.

[11] Using WCI-wide adjustments for CARB (2017) and LAO (2017), per Table 1. CARB (2017) considered banking up to a specified number; LAO (2017) and Busch (2017) provided central estimates with symmetrical uncertainty bars; and ECO (2017) provided a point estimate.

While several factors influence a market participant's decision to bank allowances, including expectations about future allowance prices, the availability and price of offset credits are also important factors. This is because covered emitters can choose to use offsets instead of allowances to satisfy a limited portion of their cap-and-trade compliance obligations. The more offsets there are and the cheaper they are relative to allowances, the more offsets will be used; and the more offsets are used, the larger the bank of allowances will be. Compliance data from California and Québec indicate that just under 159 million offsets were surrendered to regulators in the first three compliance periods (2013–2020) (see Carbon Offsets chapter in this report), or about half the size of the private allowance bank.

Because offset credit use substitutes for allowance surrenders, offsets enabled covered emitters to bank more allowances into the program's post-2020 period. Their use also increases the need for in-state mitigation efforts because offsets' climate benefits generally do not contribute to a reduction in "statewide emissions" for the purposes of California's 2020 and 2030 climate targets.[12] Most offset projects claim climate benefits in sectors that are currently not part of the state's greenhouse gas inventory (such as forests) or are located outside of California (such as a forest offset project in Alaska). As a result, historical and future offsets use increase the need for additional in-state climate mitigation efforts.

- **Finding #3:** The extent of observed private banking is larger than the contribution CARB projected would be needed from the cap-and-trade program over the period 2021–2030, raising questions about the ability of the program to act as a "backstop" policy as currently designed.

Observed banking of 321 million allowances can be compared to earlier projections about the expected contribution of the cap-and-trade program toward California's 2030 statutory emissions limit. In its 2017 Scoping Plan, CARB projected that the cap-and-trade program would need to reduce a cumulative 236 million tCO_2e over the period 2021–2030 (CARB 2017, p. 26).

Because CARB's earlier projection considered only the contribution toward California's emission reductions, whereas the observed banking outcome reflects WCI-wide allowance holdings, an additional analytical step is required. If we assume California and Québec intend their linked cap-and-trade programs to play roughly similar roles in the coming decade, then the linked cap-and-trade programs would need to deliver something on the order of 275 million tCO_2e in reductions under the assumptions of CARB's core 2017 Scoping Plan Scenario[13] — still less than the number of allowances banked from the market's first three compliance periods.

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[12] Health & Safety Code §§ 38550, 38566 (defining California's 2020 and 2030 greenhouse gas emission limits in terms of "statewide emissions").

[13] Using a 2030 cap-adjustment ratio of 1.220, based on the 2030 California cap (200,500,000 allowances) and 2030 Québec cap (44,140,000 allowances). See footnote 10.

We emphasize how important careful policy analysis is to the consideration of any potential reforms to cap-and-trade program designs. Projecting future emissions in the face of policy, macroeconomic, and technological uncertainty is challenging to say the least. Nevertheless, new public data following the November 2021 compliance event provides an opportunity to clearly assess the supply side of the market. These data show that private market participants banked 321 million allowances that originate from the market's pre-2021 period. Current regulations in California and Québec indicate that an additional approximately 2,996 million allowances will be made available through 2030 via free allocation and regular quarterly auctions;[14] and approximately 274 million more allowances are available in various government reserve and cost containment accounts (CARB 2022).

As we have observed in previous reports, the cap-and-trade program covers about 75% of California's statewide emissions and, due to allowance banking, is best understood as a *cumulative* emission reduction policy for the covered subset of statewide emissions. As a result, translating expected outcomes in the cap-and-trade program to a contribution toward an *annual statewide* emissions limit in 2030 requires careful analysis and important policy decisions (IEMAC 2020, Chapter 5).

We have not provided the necessary analysis here to address expected future emissions (i.e., the demand side of the market) nor the expected effects of the program on statewide emissions in 2030, which we believe is best conducted in the context of the ongoing 2022 Scoping Plan process (see Scoping Plan chapter in this report). Nevertheless, the allowance banking observed to date provides substantial evidence indicating the need for a comprehensive assessment of program caps in relation to California's 2030 emissions limit.

[14] Based on the 2021 through 2030 program budgets for California and Québec, excluding reserve allowances (for sources, see footnote 10), excluding the 13.2 million allowance cap adjustment made jointly by California and Québec (as described in CARB (2022)). Additional allowance retirements, including to address unsatisfied compliance obligations discharged in bankruptcy as well as to address emissions leakage in the CAISO Energy Imbalance Market, are also part of the current market design but not accounted for here.

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Emissions Market Design and Program Reform

Dallas Burtraw and Committee

Summary

The emissions market is functioning well, achieving 100 percent compliance. However, we observe an abundant cumulative supply of allowances enabling emissions at sources covered by the trading program that may undermine the ability of the state to achieve its economywide 2030 emissions reduction goal. Further, until recently the allowance price has been hovering near the price floor and could return to that level, providing a weak incentive for emissions reductions. There are three related ways that the state could build on the existing solid market platform to strengthen the market's contribution to achieving the state's economywide emissions reduction goal.

- One approach would directly address the cumulative supply of allowances that are available in the emissions market, noting that sources covered by the market constitute 75 percent of statewide emissions.
- A second approach would address the price of allowances. The allowance price provides an incentive to harvest cost-effective emissions reductions and provides a signal for innovation and investment.
- Taken separately, either of these reforms would likely increase the total value of the allowance market, but they could decrease revenue to the Greenhouse Gas Reduction Fund. A third reform would address the volatility and magnitude of revenues that accrue to the Fund.

There is enough evidence now to compel a careful look by the regulatory agency at market reforms we describe in this report. If action is needed, the more time that is taken to implement changes the greater will be the challenges, and the necessary changes will constitute more of a surprise to the market.

Introduction

The conclusion of the third compliance period (2018-2020) and the ongoing Scoping Plan process provides the Air Resources Board with the opportunity to assess the carbon market and consider potential reform. The final accounting of the emissions allowances in circulation after 2020 finds a substantial quantity of allowances have been banked for future use. Banked allowances in private accounts total more than the cumulative reductions under the emissions cap that will be implemented from 2021-2030 (see Allowance Banking chapter in this report). Moreover, a substantial number of allowances held in public accounts may enter the market if allowance price triggers are met. The allowances add to new vintage allowances and offsets to constitute the total cumulative supply of compliance instruments. Although the supply of new allowances issued annually is scheduled to reduce substantially this decade and the supply of offsets is more limited beginning in 2021, cumulative supply for the decade remains abundant.

An assessment of the market also requires analysis of allowance demand, which is influenced by economic activity including the post-pandemic recovery, regulatory programs that may incentivize emissions reductions, and other factors. In the Scoping Plan chapter in this report, we suggest that assessment of supply and demand scenarios should be an element of the Scoping Plan process, providing the foundation for dialogue at the Air Resources Board about the role of the carbon market in achieving the state's comprehensive emissions reduction goals and consideration of potential reforms to the market.

The allowance price results from the interaction of supply and demand. Low prices will provide weak incentives for investment and emissions reductions, likely requiring a greater role for regulations instead of market signals to meet climate goals. Tightening the allowance supply could be accomplished directly, which coincidentally would lead to an increase in the allowance price. Or it could be accomplished by strengthening market rules that make the quantity of available allowances responsive to the auction price, with fewer allowances available at low prices and more allowances available at high prices, as one observes in other markets. This approach provides an increasingly dynamic price collar for the market.

The allowance price is also influenced by expectations about changes to the market, which makes the way changes are implemented important. Allowance prices are tremendously difficult to forecast, which may favor a rule-based approach that adjusts allowance supply in response to the price. However, quantity and price-based approaches are not mutually exclusive and can be implemented together, as has occurred previously in California and other trading programs.

In this chapter we outline options that are available for potential reform through adjusting allowance supply and the way supply that enters the market is contingent on price. These options all firmly preserve the role of the market in efficient mobilization of cost-effective mitigation opportunities.

A reduction in allowance supply and associated increase in price is expected to increase total allowance market value -- the product of supply and price. In general, the effect of a change in allowance supply on market value depends entirely on the price elasticity of demand for allowances. In various trading programs, one observes relatively inelastic demand, meaning that a restriction in supply leads to a disproportionate increase in price and boosts total value.

However, depending on program rules, the increase in market value associated with a restriction in supply may not map into an increase in value flowing to the Greenhouse Gas Reduction Fund and in fact it may cause a reduction in the Fund. We describe two incremental program changes that would improve the reliability of Fund revenues and potentially grow the size of the Fund.

Administrative versus automatic adjustments to allowance supply

Quantity and price-based adjustments can each be implemented through *administrative interventions* or through *automatic (rule-based) adjustments.* We consider administrative interventions to be adjustments made by the regulatory agency or legislature that immediately change the cumulative market supply. Rule-based adjustments are those that are contingent on market outcomes, with the conditions under which adjustment occurs announced in advance.

Both types of adjustments have been evident in emissions trading programs previously and generally have strengthened those markets and accelerated emissions reductions. In the northeast state Regional Greenhouse Gas Initiative (RGGI), the issuance of new allowances through the auction has been reduced administratively twice to account for the substantial supply of allowances that had accumulated in private accounts through banking and in public accounts because of allowances unsold at the auction price floor. Coincidently, a rule-based reduction in supply resulted when prices rested on the price floor, and the rule-based cost containment reserve was once triggered bringing additional allowances into the market.[15] In the European Union Emissions Trading System, administrative adjustments have reduced allowance supply in each phase of the program. This has been recently supplemented by the rule-based Market Stability Reserve that changes allowance supply automatically based on the measure of the quantity of allowances in circulation (the allowance bank) (Perino 2018).

California has also previously enacted administrative and rule-based adjustments in its market, including a regulatory decision to increase the share of allowances set aside in reserve accounts, a legislative restriction on the use of post-2020 offsets, and rule-based adjustments to transfer unsold allowances to reserve accounts and to account for emissions leakage in the electricity sector. These precedents have strengthened the market, but they have not sustained the allowance price at a level that adequately promotes state ambitions, requiring an expanded role for regulatory mandates and standards to achieve the state's climate goals.

One disadvantage of an administrative approach is that it may amplify regulatory uncertainty by instituting changes as a surprise, causing parties to anticipate further possible changes in their compliance planning. In addition, it can be administratively challenging to adjust the market on a case-by-case basis. It is generally easier to identify criteria for adjustments ex ante and embody them as rules in market design. Hence, while recognizing the potential use of both approaches, we argue a rule-based approach is preferable and whenever possible the features of a rule-based approach should be built into the program design. It is important to note that an administrative adjustment such as a reduction in the issuance of new allowances always remains an available option for policymakers.

[15] See https://www.rggi.org/program-overview-and-design/design-archive

Administrative options for market reform

IEMAC has identified several options for administrative adjustments to allowance supply:

1. Changes in auctioned allowance supply

A reduction in the supply of new allowances available at auction could be implemented quickly and would increase the allowance price. As noted above, the supply restriction would be expected to increase the total allowance value (quantity times price). However, if the Air Resources Board were only to reduce the new vintage allowances sold through the auction — without also adjusting the extent to which allowances are freely allocated to utilities and industry — then it would cause a shift in the distribution of the economic value of allowances away from the Greenhouse Gas Reduction Fund to entities that receive freely allocated allowances, and likely would reduce the value flowing to the Fund.

2. Changes in freely allocated allowances to utilities

A portion of allowances are freely allocated to electricity and gas utilities, some of which must consign them to the auction and receive auction revenue on behalf of their customers. This supply of allowances could be adjusted, affecting benefits that accrue to ratepayers.

Two other elements of the way free allocation to utilities is implemented might be revised. First, the utility-owned consigned allowances are the first to be sold under the auction, taking precedence over state-owned allowances that contribute to the Greenhouse Gas Reduction Fund when auctions are undersubscribed (i.e., when auctions clear at the price floor). Although this prioritization benefits utility customers through the distribution of climate dividends, it undermines the stability of auction revenue for the Fund, which sees a precipitous drop in revenue if the price falls to the price floor and the auction is undersubscribed. Instead of prioritizing consignment allowances, an alternative approach would proportionately reduce the sale of consigned allowances and all other supplies in an undersubscribed auction. This alternative would not have any effect when auction prices clear above the price floor but could reduce volatility for revenues and achieve proportionally equal effects on free allocation recipients and Fund revenues if market prices fall to the price floor.

Second, the Committee notes that the state has an opportunity to improve the visibility of consignment allowances for utility customers to better communicate program goals and the compensation provided to ratepayers. Although many customers are not aware they receive the climate dividend, anecdotally the dividend is popular when customers are made aware of it. Today, utility revenues are rebated to all residential customers of investor-owned electric utilities on a broad basis, and thus contribute modest rate benefits for all customers. Although broad-based rebating has its own merits, policymakers might also wish to consider how consignment allowance revenues could be targeted at low-income households instead.

3. Changes in freely allocated allowances to industry

A portion of allowances are provided to energy-intensive and trade-exposed industries to prevent emissions leakage, as well as to protect industrial competitiveness and maintain employment in the state. While changes to this allocation schedule could influence economic activity in these vulnerable industries, the allocation methods were based on industry conditions over a decade ago and expected carbon market prices that are much greater than what has been observed (Economic and Allocation Advisory Committee 2010). We encourage the Air Resources Board to review how free allocation to various industries has aligned with emissions from those industries and whether the current allocation strategy effectively prevents leakage while also not overcompensating firms.

Whatever level of free allocation policymakers determine, we recommend a change in how those allowances are introduced to markets. Specifically, we recommend that policymakers require compliance entities to consign all freely allocated allowances for sale at auction, with revenues flowing back to the allowance owners. If the allowance is fully subscribed and all allowances are sold, this reform would not change the value of free allocation, but it could convey several other benefits including improving price discovery and market liquidity, market transparency, and recognition of opportunity costs in compliance decisions aligning organization interests with the state's emissions goals (Burtraw and McCormack 2017).

4. Changes in offset availability

Potential adjustments in offset availability are discussed in the chapter on Offsets in this report. It is valuable to reiterate here the observation that offsets expand the volume of compliance instruments and lower the allowance price in the short term. Because most offset credits do not lead to reductions that are counted under California's greenhouse gas inventory, they enable higher in-state emissions in sectors covered by the cap-and-trade program. Hence, offset use amplifies the need for a future reconciliation between the mitigation achieved by sources covered by the emissions cap and the share of statewide greenhouse gas reductions that is expected to come from those sources. That reconciliation may necessitate adjustment to the emissions market that should be anticipated in the Scoping Plan process.

Automatic adjustments to allowance supply

IEMAC has identified several options for automatic adjustments to allowance supplies. These adjustments are based on conditions that may be observed in the market in the future, so they are not guaranteed to affect allowance supply, but they will affect market dynamics.

1. Raising the price floor

A change in the price floor will affect expectations of future allowance prices and supply. A higher price floor could induce greater emissions abatement that temporarily

increases the allowance bank; however, if market prices fall to the new floor price, then there could be a reduction in allowance supplies that would also have long-run market supply effects. The price floor could be adjusted by a one-time price increase. However, a smoother adjustment can be implemented through a series of discrete price increases over time, which would be equivalent to increasing the annual change in the price floor to a value above the current value of five percent per year (plus inflation).

2. Introducing additional price steps

The allowance price schedule starts from the price floor and has price steps that are 50 percent and 75 percent of the way between the floor and the price ceiling. At these price steps additional allowances from the cost containment reserves are available in the market. An additional price step located 25 percent of the way between the floor and the ceiling could deliver symmetry to the allowance supply schedule. Rather than adding additional allowances as do the cost containment reserves, this price step could reduce supply below the anticipated issuance of new allowances. This limitation of allowance supply would support the price above the level it would obtain otherwise and would be expected to result in greater value for allowances entering the market. This is an approach that is embodied in the emissions containment reserve in RGGI, where 10 percent of allowances are held for sale only at a price above the reserve price trigger; a similar approach is potentially indicated in Washington state's new cap-and-trade program as well.

3. Conditioning offset availability on the auction price

Within the carbon market, offsets contain allowance cost by expanding the supply of compliance instruments. One reform could be to tether the use of offsets for compliance to the auction price, such that fewer offsets are available at low prices and are increasingly available at higher prices. The limit on offset use during a compliance period could reflect cumulative auction outcomes. This approach would clarify the role that offsets play in containing cost, while also limiting the supply of offsets when allowances supply is abundant, and prices are low.

4. Implement a quantity-based adjustment to allowance supply

The EU Market Stability Reserve implements a rule-based adjustment to the auctioned supply of allowances based on the total number of allowances in circulation, i.e., the allowance bank, at the end of every annual compliance period. This approach has been impressively impactful in the EU emissions market, leading to the anticipated cancelation of nearly one gigaton of emissions allowances in 2023, roughly equal to one vintage year of allowances in the program. However, it has been criticized for amplifying regulatory uncertainty compared to an adjustment rule based on the allowance price, and because of potentially perverse outcomes stemming from the timing of when adjustments are implemented in the EU market (Rosendahl 2019; Perino 2019; Flachsland et al. 2019).

Impact on the Greenhouse Gas Reduction Fund

Allowance market value is a product of allowance supply and price. Over the range of the market size expected this decade and the price responsiveness one observes in the market, evidence from simulation modeling using a derived elasticity of demand for emission allowances indicates that restricting supply and increasing the price of allowances would be likely to increase the market value overall. However, the increased value may not flow proportionately within the market and may in fact lead to a reduction in the value flowing to the Greenhouse Gas Reduction Fund, which provides important investments to poor communities and those that have experienced disproportionate environmental burdens.

Reforms to the cap-and-trade program can support emissions reductions in line with California's economywide climate goals. To the extent that the Greenhouse Gas Reduction Fund is relevant to investments that need to occur to achieve the state's goals, reforms must be designed to improve the stability of auction proceeds contributing to the Fund, and where possible increase the value of those proceeds.

Two changes to program rules are necessary to satisfy this criterion.

1. Require the consignment of all freely allocated allowances including those to industry to the auction before they can be used for compliance. The proceeds from the sale of allowances would be returned proportionately to their owners in a manner analogous with utility-consigned allowances currently.
2. Remove the priority sale assigned to consigned allowances when the auction is undersubscribed due to a clearing price at the price floor or at a newly introduced emissions containment reserve price and scale the sale of allowances from all sources proportionately.

By ensuring proportional changes to freely allocated and auctioned allowance supply, these changes would maintain or grow Fund revenues if the Air Resources Board or legislature decide to implement other program reforms that we describe.

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Carbon Offsets

Lead authors: Danny Cullenward and Dallas Burtraw

- **Summary:** In the Western Climate Initiative cap-and-trade program's first three compliance periods (2013–2020), covered entities used almost 159 million offset credits for compliance purposes. Nearly 139 million offsets were used by covered entities in California. About 80% of all offset credits come from CARB's forest offset protocol, which has been criticized for issuing credits that may not reflect real climate benefits and for failing to adequately insure against the risk of wildfire and other carbon losses. We review the use of carbon offsets in California's program, criticisms of CARB's forest offset program's performance relative to statutory requirements, and potential options for reform.

How carbon offsets work

This chapter addresses the effect of carbon offsets on greenhouse gas emissions. Although offsets can also provide benefits to local environmental quality and regional economic development, we do not address those topics here. Nor do we evaluate concerns that offset use may perpetuate pollution in historically overburdened communities.

The cap-and-trade program provides incentives to reduce greenhouse gas emissions in covered sectors, which are responsible for about 75% of California's statewide emissions. Carbon offsets extend those incentives to sectors and jurisdictions not covered by the cap-and-trade program, most notably in the natural and working lands sector. The benefits of reducing emissions and increasing carbon sequestration in uncapped sectors can be significant, but the challenge facing governments is how to accurately measure and reward outcomes in uncapped sectors.

Carbon offset programs allow participating projects to earn offset credits, each worth 1 tCO_2e, for voluntary climate mitigation efforts that are recognized outside of the cap-and-trade program's covered sectors—that is, in a part of the economy where emitters are not directly regulated under the cap-and-trade program. Because carbon dioxide and other key greenhouse gas emissions are long-lived and well-mixed in the global atmosphere, the climate benefit of avoiding those emissions or removing carbon dioxide from the atmosphere does not meaningfully change based on location. In line with this principle, offset projects are sometimes based in California, but often they are located throughout the United States.

In a cap-and-trade program without offsets, all necessary emission reductions must occur within capped sectors. When a cap-and-trade program allows covered emitters to use carbon offsets in addition to the normal supply of pollution allowances, however, then the total pollution allowed within capped sectors increases by the number of offsets used—credits that, in turn, represent an equal number of climate benefits claimed

outside the capped sectors. For example, an oil refinery in the Los Angeles area could buy offset credits from a forest management project in Alaska that claims to delay or avoid the harvest of commercially viable timber under the terms of California's forest offset protocol. By expanding the number of compliance instruments in California's cap-and-trade program, this transaction increases the total climate pollution allowed in capped sectors in exchange for climate benefits claimed in the Alaska forest. The result: emissions increase in California's industrial sector but decrease in Alaska's forestry sector.[16]

Accurate carbon offset programs do no harm to the climate: they neither accelerate the pace of overall climate mitigation nor detract from it. Instead, they act to reduce total program compliance costs (by providing a greater number of options by which covered emitters can comply with program requirements) and create funding for mitigation activities outside program caps (as covered emitters' purchase of offset credits funds climate projects in uncapped sectors like forestry).

Most offset projects do not affect the emission reductions that are required by the state's economy-wide greenhouse gas limits because they are not included in the official greenhouse gas emissions inventory. However, offset credits enable higher pollution in sectors covered by the emissions cap. Hence, their use can make achieving statewide greenhouse gas limits more difficult because emissions from somewhere else in the inventory must be reduced to account for increased emissions from covered sources, or the emissions cap for covered sources must be reduced instead. Moreover, when the offsets program issues more credits than the climate benefits it achieves in practice, it undermines the mitigation actions taken by other covered entities and increases net emissions associated with the emissions market. To protect the integrity of the emissions market, offset credits must accurately reflect climate benefits.

Carbon offsets in California

California's cap-and-trade program allows covered emitters to use carbon offsets to satisfy part of their compliance obligations, in addition to allowances. Although offset credits can be issued by any regulator participating in the linked Western Climate Initiative (WCI) cap-and-trade program, California has issued about 99.5% of credits to date and is therefore the de facto offsets regulator. CARB's United States (U.S.) Forest Projects protocol is responsible for about four-fifths of all offset credits issued in the WCI program (Table 1).

[16] We note that sectoral accounting details matter for determining compliance with California's statewide 2020 and 2030 emissions limits; see Health & Safety Code §§ 38550, 38566 (defining limits in terms of "statewide emissions"). Most offset credits are issued for sectors and/or jurisdictions that are not included in California's official statewide greenhouse gas inventory (CARB 2021a). When offset credits are used by covered emitters in California, however, they enable higher emissions that are tracked in California's inventory in exchange for climate benefits claimed outside of the inventory. Thus, although perfectly credited offsets have no impact on net greenhouse gas emissions, their use strictly increases statewide emissions as that concept is currently tracked in California's inventory and used to evaluate compliance with the 2020 and 2030 emission limits.

Table 2: Offset credit issuance by protocol (CARB 2022)

Jurisdiction	Protocol	Credits (tCO_2e)	Share (%)
California	U.S. Forest Projects [17]	189,811,822	81.7%
	Ozone Depleting Substances	24,305,693	10.5%
	Mine Methane Capture	8,994,363	3.9%
	Livestock Manure Digesters	8,250,214	3.5%
	Urban Forest Projects (not used)	—	—
	Rice Cultivation (not used)	—	—
Québec	Ozone Depleting Substances	578,785	0.2%
	Landfill Site Methane Destruction	473,615	0.2%

California's cap-and-trade program limits the number of offset credits each covered emitter can use. By regulation, that limit was 8% of a covered emitter's total compliance obligations for each of the first three compliance periods (2013–2020). In practice, covered emitters in California surrendered almost 139 million offsets, or about 6.3% of their total emissions during this period; WCI-wide usage came to just under 159 million offsets, or about 6.2% of total emissions (see Table 2). The offsets usage limit falls to 4% (for emissions in years 2021–2025) and then increases to 6% (2026–2030), with no more than half of the total post-2020 usage coming from projects that do not generate "direct environmental benefits" to local air or water quality in California.[18]

State law requires that offset credits used in California reflect climate benefits that are "real, permanent, quantifiable, verifiable, and enforceable."[19] Credited climate benefits must also be additional in relation to "any greenhouse gas emission reduction otherwise required by law or regulation, and any other greenhouse gas emission reduction that would otherwise occur."[20] CARB further defines the additionality standard by requiring "conservative" baseline emission scenarios, assumptions, and methodologies that "are more likely than not to understate net [greenhouse gas] reductions or [greenhouse gas] removal enhancements."[21]

Another important concern to California stakeholders is the impact of offsets on broad environmental outcomes including air quality, water management, and ecological sustainability. By shifting some climate mitigation efforts away from covered sources in California, carbon offsets could negatively affect air pollution at facilities located in historically overburdened communities. California indirectly addresses this concern with the requirement that at least half of post-2020 offsets use provides direct environmental benefits to the state. The extent to which this requirement addresses local pollution

17 Total credits reported. Included in this amount are 29,819,664 credits in the forest buffer pool.
18 Cal. Code Regs. title 17, § 95854; *see also* Health & Safety Code § 38562(c)(2)(E).
19 Health & Safety Code § 38562(d)(1).
20 Health & Safety Code § 38562(d)(2).
21 Cal. Code Regs. title 17, § 95802 (see definition of "Additional" and "Conservative").

burdens depends on how expansively CARB interprets "direct" benefits, as well as whether the benefits accrue to burdened communities.

Because California's forest carbon offsets program supplies about 80% of total offset credits in the WCI cap-and-trade program, we focus the remainder of this chapter on the performance of CARB's forest offsets protocol (CARB 2015).

Table 3: Compliance Data Summary[22]

Jurisdiction	Period	Emissions (tCO_2e)	Offsets (tCO_2e)	Offsets (%)
WCI Total	2013–2014	328,160,746	13,096,979	3.99%
	2015–2017	1,162,546,144	68,806,023	5.92%
	2018–2020	1,090,420,561	76,886,203	7.05%
	Total	2,581,127,451	158,789,205	6.15%
California [23]	2013–2014	291,496,043	12,798,167	4.39%
	2015–2017	986,400,626	62,717,868	6.36%
	2018–2020	912,241,974	63,354,849	6.94%
	Total	2,190,138,643	138,870,884	6.34%
Québec [24]	2013–2014	36,664,703	298,812	0.81%
	2015–2017	176,145,518	6,088,155	3.46%
	2018–2020	178,178,587	13,531,354	7.59%
	Total	390,988,808	19,918,321	5.09%

Offset performance concerns – baselines and additionality

Recent evidence indicates that California's forest offsets program is not achieving statutory standards. In a peer-reviewed publication, Badgley et al. (2022)[25] report an independent audit of improved forest management (IFM) forest offset projects and conclude that about 30% of credits do not reflect real climate benefits (equal to about 30 million tCO_2e in the study's sample), due to problems with the regulation of projects' baseline scenarios.

An offset project's baseline scenario describes what the project says would happen, counterfactually, in the absence of income from the sale of offset credits. Because the number of offset credits a project receives is calculated based on the difference

22 The calculations behind this table are available at this link: https://calepa.ca.gov/wp-content/uploads/sites/6/2022/01/IEMAC-Report-carbon-offsets-Table-2.xlsx

23 Compliance data are available for California at this link: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/cap-and-trade-program-data.

24 Compliance data are available for Québec at this link: https://www.environnement.gouv.qc.ca/changements/carbone/documentation-en.htm.

25 One of the IEMAC members (Cullenward) is a co-author on this study.

between a project's baseline scenario and what actually happens, projects can earn the wrong number of credits if their baseline scenarios are inaccurate or biased.

Following the challenging experience with first-generation carbon offset programs, which allowed projects to specify their own baseline scenarios without significant guidance, California adopted a "standardized approach" in which baseline methodologies are fixed in offset protocols (Haya et al. 2020). CARB's forest protocol (CARB 2015) imposes three requirements on IFM projects' baseline scenarios, which must: (1) be legally feasible (Section 3.4.1), (2) be economically feasible (Section 5.2.1(e)), and (3) result in average carbon stocks that do not fall below regional averages known as "common practice" (Section 5.2.1(f)).

Badgley et al. showed how CARB's construction of common practice averages together dissimilar species, such that carbon-dense coastal forests earn credit for not harvesting their lands down to the carbon levels found in arid interior forests—even though different carbon levels in these two areas reflect differences in the forests' species composition, rather than the management activities projects conduct to store additional carbon. The study found evidence that project developers preferentially select projects with naturally carbon-dense species that earn extra, unjustified credits when compared against the unrepresentative regional averages found in CARB's offset protocol. This evidence indicates the baselines used in California's forest offset program are often biased.

The same study also demonstrated how offset projects construct questionable baseline scenarios that are optimized to earn maximum credits, rather than to reflect realistic or commercially reasonable scenarios (Badgley et al. 2022, Figure 2). This outcome is possible because the forest offset protocol's legal and economic feasibility requirements allow for any baseline scenarios that *could* happen, without regard to whether the scenario is likely to happen. A project does not have to show that the baseline scenario is the most profitable land use activity, nor that the baseline scenario represents typical management practices for a given forest type. As a result, it is possible for projects to select scenarios that are unlikely to occur, but nevertheless legally and economically feasible, and therefore eligible for crediting.

We note that CARB (2021b) disputes the results of Badgley et al. (2022),[26] which have been published in a peer-reviewed academic journal. The same journal invited a commentary from independent scientists who endorse the continued use of forest carbon offsets and describe the study's results as a "call to action to redouble efforts at integrating the latest carbon science into effective and timely policy solutions" (Anderson-Teixeira & Belair 2022).

[26] CARB's disagreement with the authors focuses primarily on the algorithm the authors used to classify forests, and the use of species-specific comparisons in place of aggregation to calculate average carbon stocks.

Additional in-depth reporting from investigative journalists has uncovered evidence that raises questions about whether entire projects are non-additional—in other words, projects that appear to be earning credit for business-as-usual land management activities. For example, a large project in Alaska earned millions of offset credits because it claimed to avoid significant harvests, only a few years before the landowner announced the end of all logging on its lands.[27] Similarly, nonprofit conservation groups have enrolled lands in the forest offsets program that had long been conserved, raising questions about how likely those lands were to be subject to the harvests claimed in their baseline scenarios.[28]

Offset performance concerns – permanence

A second important challenge facing carbon offsets concerns the statutory permanence requirement, as the IEMAC discussed in an earlier report (IEMAC 2018, Chapter 5). CARB's regulations define the statutory term "permanent" as requiring only 100 years of protection.[29] Thus, fossil carbon emissions can be justified in California's program by forest offset projects that are required to protect their carbon for a term of only 100 years.

To protect against the possibility that trees might die due to fire, drought, disease, and other impacts over the next 100 years, CARB's forest offset protocol implements a buffer pool. Each project contributes a share of the credits it earns to the buffer pool based on a series of risk factors (CARB 2015, Appendix D), with typical contributions in the range of 15-20%. In the case of an "unintentional reversal"—such as a wildfire—affected offset projects verify their carbon losses within 23 months and CARB retires an equal number of credits from the buffer pool.[30] So long as the buffer pool has credits remaining, the environmental integrity of the credits in circulation is preserved and the system is kept whole.

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27 Paul Koberstein and Jessica Applegate, Carbon Conundrum, *Earth Island Journal* (Winter 2021) (questioning the additionality of Sealaska's IFM project); Jacob Resnick, Sealaska Corporation says it's quitting logging, *Alaska Public Media* (Jan. 12, 2021) (reporting Sealaska's subsequent decision to end all logging).

28 Lisa Song and James Temple, A Nonprofit Promised to Preserve Wildlife. Then It Made Millions Claiming It Could Cut Down Trees, *ProPublica* and *MIT Technology Review* (May 10, 2021) (reporting on a Massachusetts-based conservation organization hosting a California forest offset project). This phenomenon has also been documented in the voluntary carbon offsets market. Ben Elgin, These Trees Are Not What They Seem, *Bloomberg Green* (Dec. 9, 2020).
CARB's response to the ProPublica article is found at: https://ww2.arb.ca.gov/sites/default/files/2021-04/nc-carb-response-to-propublica-forest-questions.pdf. ProPublica responded further at: https://www.propublica.org/article/the-california-air-resources-board-challenges-our-carbon-credits-investigations-we-respond.

29 Cal. Code Regs. title 17, § 95802 (defining "permanent" as a requirement that "all credited reductions endure at least 100 years"). However, carbon dioxide emissions from fossil fuel use remain in the atmosphere for hundreds to thousands of years (Archer et al. 2009) and have impacts that are effectively permanent in geologic time (Pierrehumbert 2014).

30 Cal. Code Regs. title 17, § 95983.

Unfortunately, the record 2020 and 2021 wildfire seasons raise concerns about whether the buffer pool is adequately capitalized to protect against future risks. The buffer pool contains about 30 million credits as of this writing (CARB 2022) but will soon recognize significant losses due to several carbon offset projects that burned in the last two years. The Climate Trust (2021) estimates these losses could be up to 6.8 million credits, or more than a fifth of the credits set aside to protect against 100 years of risk. Although wildfire and other forest mortality risks vary geographically and are expected to increase with climate change, California's buffer pool does not account for either factor (Anderegg et al. 2020). Thus, there are important questions about whether the buffer pool is large enough to achieve CARB's 100-year permanence standard.

Options for reform

If policymakers decide that not all of California's forest offset credits are meeting statutory standards, there are several options they could consider for reform. Each takes a different approach to correcting for problems with offset credits while also preserving the status quo policy objective of funding climate mitigation projects outside of capped sectors.

First, policymakers could identify the scale of non-additional or otherwise non-compliant crediting and reduce future allowance budgets via an *ex-post* cap adjustment. This approach would preserve the overall environmental integrity of the cap-and-trade program while recognizing the challenges associated with precisely determining offsets' emissions outcomes via standardized *ex ante* methods. Such an approach could also be conducted periodically to ensure that any future imperfections are identified and corrected. An *ex-post* assessment could also tally the measure and distribution of direct environmental benefits that are associated with offset use, using the State's environmental justice screening tool to provide information for possible reform of program requirements if needed.

Second, policymakers could adopt the approach taken by Washington State in its recent cap-and-trade legislation, which effectively includes an automatic allowance budget adjustment. Instead of enabling offset usage "above" (or in addition to) allowance budgets—as is done in California—Washington decided to enable offset usage "under" program caps. Specifically, Washington's legislation provides methods for determining emissions budgets as the sum of allowances and carbon offsets, rather than by reference to the number of allowances only.[31]

Washington's alternative budgeting approach avoids an important fragility common to conventional carbon offsetting programs: to do no harm, conventional offsets must perfectly calculate climate benefits. In contrast, offset credit imperfections do not undermine climate mitigation policy goals under Washington state's paradigm. Because

[31] RCW 70A.65.070(2), https://app.leg.wa.gov/RCW/default.aspx?cite=70A.65.070. As of this writing, Washington's Department of Ecology was developing but had not finalized regulations implementing this requirement.

Washington's allowance budget is defined such that the supply of allowances plus offsets is intended to achieve a statewide emissions target, offset use is factored into the determination of the total pollution budget provided to covered emitters. As a result, the allowance budget design anticipates the possibility that offsets could be imperfect and fully contains that possibility with an automatic cap adjustment that reduces allowance supplies based on offset use. (One potential concern with this approach is that it would not prevent low-quality offset credits, but merely contain their consequences. This outcome could indirectly dilute quality standards in voluntary carbon offset markets, which often compare their private standards to public methodologies.)

Third, policymakers could sunset the forest carbon offsets program and replace it with public expenditures funded through the Greenhouse Gas Reduction Fund. Like the "under-the-cap" approach taken in Washington, this approach would eliminate the need for projects to perfectly calculate climate benefits. Policymakers could continue to use and refine offset credit protocols to estimate the climate benefits of participating projects, but would not issue credits to projects; instead, they would directly fund those projects they deem eligible and worthy. This alternative would provide policymakers with a significantly greater degree of control over the sectors and approaches they desire to support, including the ability to concurrently recognize or prioritize multiple ecological, historic, and community development factors.

The IEMAC recognizes that any structural changes to the carbon offsets program could raise concerns for market participants that have made decisions based on the assumption that current program regulations will continue indefinitely. Although stable market conditions are desirable as a general matter, the policy goal of pursuing stable expectations is not absolute. CARB has already indicated, for example, that it plans to review new evidence in a future public process concerning the performance of the offsets program (including the current treatment of wildfire risks) (CARB 2021b). We note that the potential reforms discussed here could all be considered and enacted through similar public processes that would provide public notice and an opportunity for stakeholder engagement. Critically, none of the possibilities suggested above would affect the compliance eligibility of any offset credits, nor the ability of market stakeholders to buy and sell offset credits among themselves. Thus, while the potential reforms discussed above would lead to significant policy changes if enacted, those changes are best understood as potential modifications to the supply of allowances and offsets.

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Emissions Leakage Mitigation Measures

Lead authors: Meredith Fowlie and Dallas Burtraw

Levels of climate ambition—and the stringency of climate policies—are escalating in jurisdictions such as Europe, Canada, and California. At the same time, a majority of global greenhouse gas (GHGs) emissions remain unregulated.[32] This poses a formidable challenge for jurisdictions working to fight global climate change with ambitious local or regional policies.

When only a subset of emissions sources is subject to costly regulations, industrial production and associated emissions may shift to less regulated jurisdictions – a process known as emissions "leakage". Leakage has been a defining concern in the design and implementation of California's GHG cap-and-trade program.

In principle, emissions leakage can be mitigated by imposing a commensurate compliance obligation on the GHG emissions embodied in imported products (and exempting emissions embodied in exports). Border carbon adjustments (BCAs) can help level the carbon playing field for domestic and foreign suppliers. An alternative approach uses production incentives to mitigate leakage risk. Under a cap-and-trade regime, these production subsidies can be conferred in the form of GHG permits allocated for free on the basis of industrial output (sometimes referred to as "output-based allocation").

Notably, California's GHG cap-and-trade policy integrates both of these approaches. Electricity importers into California must surrender allowances on the basis of the GHG emissions intensity of imported power. Outside the electricity sector, emissions intensive and trade exposed (EITE) producers receive free allowance allocations on the basis of industrial output.

As California's GHG regulations become more stringent, GHG permit prices – and the potential for emissions leakage – will increase. Now is an opportune time to assess whether California policies are achieving the desired objectives. This chapter reviews the empirical evidence and identifies some policy design challenges and opportunities.

California's border carbon adjustment

GHG emissions associated with electricity consumption have been regulated under the cap-and-trade program since 2013. GHG emissions from in-state producers are regulated directly, while electricity importers have an obligation to purchase permits for GHG emissions associated with imports. With almost a decade of data to analyze, researchers have been investigating the impacts of the GHG cap-and-trade program design on western electricity market operations and associated GHG emissions.

[32] The World Bank estimates that existing GHG pricing programs cover 21.5% of anthropogenic emissions. https://carbonpricingdashboard.worldbank.org/map_data

To estimate the causal impacts of a policy intervention on emissions outcomes, we need to compare the GHG emissions we observe under the policy against a credible estimate of the emissions patterns we would have observed absent the policy (i.e., the counterfactual). In the context of California's GHG cap-and-trade program, estimating counterfactual GHG emissions is complicated by two factors.

- **California climate policies impact the entire western electricity market:** All electricity producers in the integrated western electricity market are directly *or indirectly* impacted by California's cap-and-trade program as the market shifts production away producers with compliance obligations and towards out-of-state producers with no compliance obligations. Thus, comparing emissions changes at in-state plants against emissions changes at plants in neighboring states can overstate policy impacts.

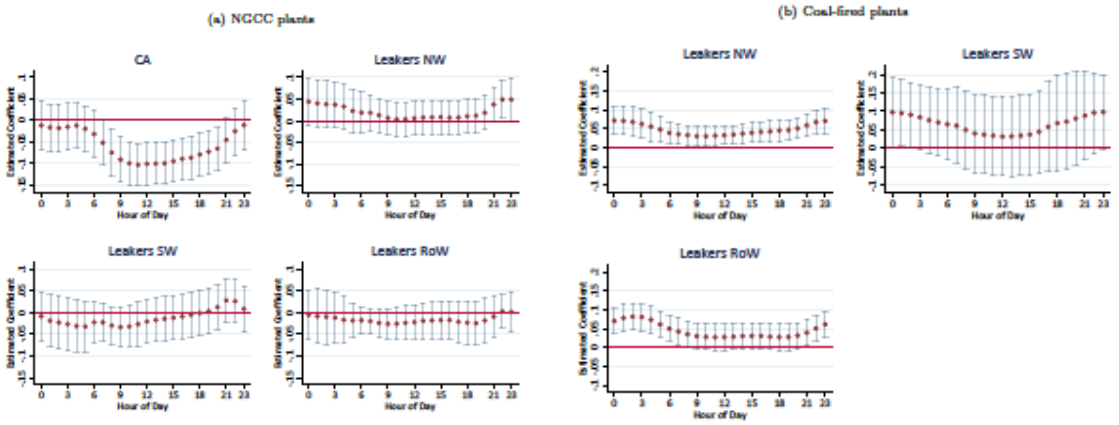
- **Coincident changes confound impact analysis:** The introduction of California's GHG trading program coincided with other big changes in the western power market (such as the closure of the San Onofre nuclear generating station - SONGS, and increased support for renewable energy). It can therefore be challenging to disentangle the effect of California's carbon pricing policies from these confounding factors.

Researchers are addressing these challenges in a variety of ways. Once recent paper by Lo Prete et al. (2021) matches electricity generating units in the WECC (western electricity coordinating council) with observationally similar electricity generating plants outside of WECC. This approach assumes that matched "control" plants outside of WECC are not impacted by California's climate policies and can be used to estimate what production patterns in the WECC market would have looked like absent the GHG cap-and-trade program. A second approach uses detailed models of the 2019 western wholesale electricity market to simulate market outcomes with and without the border adjustment

Starting with the first approach, Lo Prete et al. (2021) analyze the impacts of California's GHG cap-and-trade program on plant-level electricity production and market-level GHG emissions over the first four years of policy implementation. The difference-in-differences comparison of power plant operations between WECC/matched control plants before/after the introduction of California's cap-and-trade program provides the basis for estimating program impacts on WECC plant utilization rates.

The authors estimate relative *decreases* in electricity generation among California producers and relative *increases* in electricity generation among out-of-state generators supplying the western market in the years following the introduction of the GHG cap-and-trade program. These findings suggest that electricity production at directly regulated gas plants in California is being reallocated to out-of-state producers. However, a closer look at the data reveals underlying diurnal patterns that are not so consistent with this synchronous substitution story.

The figures below show the estimated reductions in electricity production at California (CA) gas plants relative to matched counterparts in other parts of the country across hours of the day. Notably, reduced utilization at California gas plants is concentrated during daylight hours. In contrast, the right figure shows how relative increases in capacity utilization at western coal plants (outside California) happens in the evening hours. If these relative changes in utilization rates at in-state versus out-of-state power plants were driven by permit-price-induced changes in relative operating costs, changes in utilization rates should be *coincident* given very limited energy storage capacity.



Notes: This figure is taken from Lo Prete et al (2021). The left panel summarizes relative changes in utilization rates at natural gas plants (relative to matched controls). The right panel summarizes relative changes at coal plants (relative to matched controls). "Leakers" refers to power plants that are located outside of California but inside WECC.

What explains the relative reduction in the capacity factors of California's gas plants during daylight hours and the relative increase in the utilization of coal plants in neighboring western states in evening hours? The retirement of the large San Onofre nuclear power plant (SONGS) in 2012 and accelerated investment in solar PV are two factors that likely contribute to these changes. In addition, there's another kind of emissions leakage that could be contributing to the increased coal generation. If out-of-state coal generation is being imported into California as "unspecified" power –without an identified generation source and associated emissions rate - then increased coal utilization could reflect a market response to the assignment of GHG compliance obligations for in-state versus out-of-state producers.

Two recent papers investigate alternative channels through which California's GHG trading program might alter the carbon footprint of imported electricity. Under the current California market design, the GHG compliance obligation for "unspecified" imports is

determined on the basis of a default GHG emissions rate. If imports can document a carbon intensity that is lower than the default, they can reduce their compliance obligation. This GHG accounting system creates an incentive to preferentially allocate low carbon resources in neighboring states to California. This resource "shuffling" understates the carbon footprint of California's electricity imports.

Fowlie, Peterson, and Reguant (2021) and Xu and Hobbs (2021) both use detailed models of the western wholesale electricity market to simulate market outcomes with and without this border adjustment. Both studies document significant potential for resource shuffling. Both studies also investigate an alternative `uniform' border carbon adjustment that limits importers' ability to claim GHG emissions below a prescribed level. Notably, under this alternative, the potential for resource shuffling is limited and emissions leakage is more effectively mitigated.

Summary: Researchers have documented significant potential for GHG emissions leakage and resource shuffling in the western wholesale electricity market. Attempts to empirically estimate the extent to which GHG emissions leakage is happening are confounded by the effects of coincident policy changes and market developments. That said, observed patterns of GHG emissions across the western market are generally consistent with some resource shuffling. Research has further shown that limiting suppliers' ability to claim carbon intensities below the BCA default rate could more effectively mitigate leakage potential.

A BCA design that assigns the same emissions intensity to all out of state imports may be deemed discriminatory and thus legally suspect. However, in the context of California Independent System Operator (CAISO)'s energy imbalance market (EIM), California has devised an innovative way to account for assessed GHG leakage. The CAISO EIM has the only Federal Energy Regulation Commission (FERC)-approved tariff that includes an explicit carbon price.[33]

In the EIM market, out-of-state bidders must include the carbon price (based on facility-specific emissions factors) as part of their bid when they elect to seek dispatch to California load serving entities (LSEs) (as opposed to transact within the non-California EIM territory). Ex post, the GHG footprint of California imports in the EIM market are obsessed. To the extent that assessed GHGs exceed those reflected in EIM bids, a commensurate number of GHG credits are deducted from the state budget.

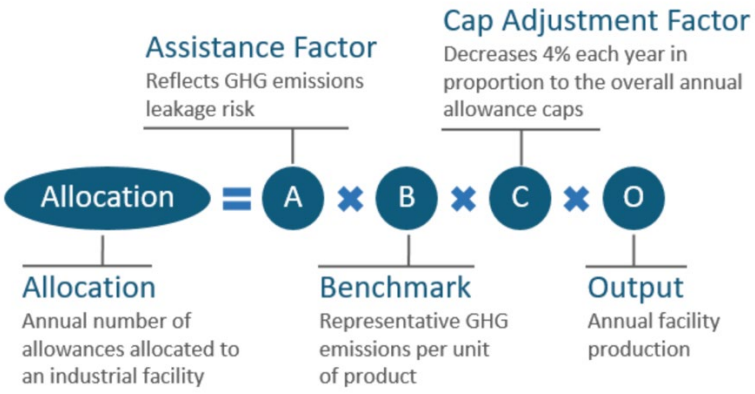
Efforts are now underway to launch an extended day-ahead market (EDAM) to include Western entities. This has the potential to further optimize supply and transmission resources and advance clean energy goals across the West. However, it could also lead to increased amount of emissions leakage in California. This presents a challenge – and an opportunity—to further innovate around GHG accounting to accommodate this larger market.

[33] *Cal. Indep. Sys. Operator Corp.*, 153 FERC ¶ 61,087, at PP 9-11, 57 (2015).

Recommendation – AB 32 requires that CARB account for the GHG emissions associated with electricity imports into California. CARB should engage to provide expert advice to CAISO staff on GHG accounting approaches that are being considered as part of the EDAM market design. CARB should explore the possibility of making ex post cap adjustments to offset leakage assessed in the EDAM. This is a promising approach insofar as it presents no significant legal risks. That said, extending this approach to the EDAM will present potential technical implementation challenges that will merit careful design consideration.

Output-based GHG allowance allocations (industrial sectors)

Output-based rebating of permits offers an alternative approach to mitigating emissions leakage. CARB uses this approach for industrial producers. The original formula used to calibrate these allowance allocations is summarized below:



Annual facility allowance allocations depend on facility-specific output scaled by an assistance factor, a product-specific benchmark, and cap adjustment factor:

- Assistance factors were originally intended to reflect sector-specific leakage risk.
- Benchmarks are defined at the NAICS6 level in most cases.
- Adjustment factor declines each year in proportion to the overall annual allowance caps (and decreases 4 percent per year during the period 2020-2030).
- The allocation is based on updated information about annual facility production (i.e., output) so as to avoid windfall and undeserved free allocation of allowances and to maintain the incentive to boost production.

Notably, under AB 398, assistance factors were set to 100 percent for all sectors. Thus, production subsidies are now targeted purely on the basis of emissions intensity.

Output-based allocation updating can confer important leakage mitigation benefits. But it also comes at a cost. First, an opportunity cost is incurred when allowances are allocated for free to industrial producers. In 2020, over 58 MMT of allowances were allocated for free to industrial producers on the basis of output. At an allowance price of around $17/ton, this allocation constitutes roughly $1 billion in potential revenue diverted from the greenhouse gas reduction fund that is used to support program-related investments. Second, output-based rebating increases the abatement costs incurred to meet the emissions cap when it dilutes the incentive to reduce production at entities receiving the production subsidy. Given these costs, it is important to judiciously target subsidies at industries truly at leakage risk.

Output-based subsidies should ideally be targeted towards firms or industries that face the greatest leakage risk. This risk will be greatest in those industries where emissions intensive foreign production is highly responsive to policy-induced changes in domestic operating costs. Given the practical challenges with assessing leakage risk at a granular level, policy makers have been inclined towards simpler approaches such as the one used in California.

Research by Fowlie and Reguant (2021) empirically investigates the extent to which international trade flows, and associated foreign emissions, respond to changes in U.S. energy costs. They estimate industry-specific measures of emissions leakage risk to capture the increase in foreign emissions associated with incremental reductions in domestic production. Notably, they find relatively low leakage risk for several emissions intensive industries that are not highly trade exposed. These authors go on to show how allocating permits to emissions intensive industries that are not highly trade exposed incurs the costs of leakage mitigation while delivering a fraction/none of the leakage mitigation benefits.

Recommendation: Now is an opportune time for CARB and the legislature to re-visit the approach it currently takes to calibrate the output-based allocations to industrial sources and sectors. In California, leakage-mitigating subsidies are allocated on the basis of emissions intensity, regardless of the level of trade exposure. Over-allocation of allowances to industries that face low levels of leakage risk incurs substantial costs in excess of leakage mitigation benefits.

Reducing the assistance factor (or updating emissions benchmarks) for industries where output-based subsidies are deemed excessive could improve subsidy targeting and reduce the opportunity costs incurred to mitigate leakage. Moreover, pursuant to the concern that California's GHG allowance budget is not sufficiently stringent to drive the immediate emission reductions needed in this decade (see Chapter 3), reducing the number of permits allocated to industry offers a way to increase program stringency.

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