2023 ANNUAL REPORT OF THE INDEPENDENT EMISSIONS MARKET ADVISORY COMMITTEE

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Introduction

Dallas Burtraw and Danny Cullenward

This is the sixth annual report of the Independent Emissions Market Advisory Committee (IEMAC), which was established by AB 398 in 2017. Pursuant to Health and Safety Code § 38591.2, the Committee is directed to report annually to the California Air Resources Board (CARB) and the Joint Legislative Committee on Climate Change Policies on the environmental and economic performance of California's carbon market and other relevant climate policies.

Across its first five annual reports, the Committee has commented on the role and performance of the carbon market, which now plays a larger role in the state's overall climate policy portfolio than it did when it was first created. As the Committee has emphasized, the carbon market adds an important element of cost effectiveness and provides an incentive to achieve additional low-cost emission reductions that might not otherwise be achieved through direct regulation. The market's carbon price also signals the state's long-term commitment to its climate policy goals and can help guide new investments. A well-designed emissions limit with the market's supply-demand balance in order provides the greatest possible confidence of achieving greenhouse gas reduction goals.

The IEMAC's 2023 report arrives at an important time for the carbon market. The program completed its eleventh year of successful administration and compliance, with policymakers and stakeholders increasingly focused on its future. In 2023, CARB began a series of informal workshops to discuss potential updates to the program to increase its ambition in line with the 2022 Scoping Plan. The outcome of CARB's formal regulatory process, which is expected to begin in 2024, will be especially important in charting the carbon market's future — a future that matters not just for California's climate goals, but also for other jurisdictions that directly collaborate with California or look to its example for guidance.

The Committee has commented previously on several issues now before CARB. Central to the potential update to the carbon market is an adjustment of allowance supply and how allowances are initially distributed. The program update provides an opportunity for CARB to reevaluate the balance between freely allocated and auctioned allowances and the impact of the design on affordability, leakage, and proceeds accruing to the Greenhouse Gas Reduction Fund. The Committee welcomes CARB's discussion of potential adjustments to future allowance supplies that address the accumulation (or "bank") of unused allowances in private accounts and options for post-2030 program allowance budgets. We have observed that changes in the allowance supply will likely change the allowance price which will affect the financial value of banked allowances, potentially constituting a windfall increase in the value of banked allowances. The committee has discussed the advantages of rule-based adjustments to

the market including for example a program design that automatically locks in emissions reductions stemming from regulatory programs by ratcheting down the market allowance supply. For two years the Committee has engaged the Environmental Justice Advisory Committee in considering whether emissions reductions are achieved evenly and to the benefit of disadvantaged communities. The program update provides an opportunity to ensure this outcome as well.

The Committee has repeatedly emphasized the importance of providing confidence in the program's continued operation, which is relevant to shaping investor expectations and achieving cost-effective reductions. Last year's IEMAC report included a chapter introducing some of the legal issues that might arise in the market's operation after 2030. It recommended that policymakers take appropriate steps to clarify the program's post-2030 future, to which CARB's subsequent workshops have meaningfully contributed. Whether or not legislative action is legally required, the Committee highlights the value that legislative reauthorization would provide.

The Committee notes that California has recently increased the pace of its statewide emission reductions. The most recent inventory data indicate statewide emission reductions fell about 11.6 million tCO_2e/year from 2019 through 2021 — a period that includes the slowdown from the global pandemic that led to a sharp one-time reduction in emissions as well as the first major recovery year. Emissions in 2021 were reported at 381.3 million tCO2e. CARB is projecting a provisional emission reduction of about 10.9 million tCO_2e in 2022. The trend since 2019 is a significant improvement over the trend from 2017 through 2019, for which CARB reports emission reductions of about 3.0 million tCO_2e/year. Nevertheless, the faster pace in recent years is not yet on track to achieve either the minimum statutory target of 258.6 million tC02e set by SB 32 (40% below 1990 emissions) by 2030 nor the more ambitious 2022 Scoping Plan Scenario 224.1 million tCO2e (48% below 1990 emissions) by 2030. Together, these trends highlight the importance of clarifying the carbon market's future.

This year's annual report contains four chapters on greenhouse gas accounting, carbon market links with other jurisdictions, affordability, and carbon management. We hope it will contribute to some of the pressing questions about the design of the carbon market and its role in furthering California's statewide greenhouse gas emission limits. A brief summary of each chapter follows.

Greenhouse gas accounting. The first chapter addresses greenhouse gas accounting systems in California. Emissions accounting is central to the design and effectiveness of climate policy programs. California's greenhouse gas emissions accounting system includes three key components: the statewide greenhouse gas inventory used to track compliance with statutory emission limits, the mandatory reporting regulation under which CARB calculates compliance obligations in the carbon market, and CARB's official estimate of 1990 emissions, which forms the baseline against which statutory targets for 2020, 2030, and 2045 are expressed.

Notably, the chapter describes how the exclusion of biogenic CO2 emissions from the statewide greenhouse gas inventory may exaggerate the climate benefits of replacing fossil fuels with biofuels in the transportation sector. It also illustrates how updates to the statewide greenhouse gas inventory to improve the inventory's accuracy have also had the practical effect of weakening California's statutory policy targets, a downside that could be mitigated by updating the 1990 emissions baseline. Finally, it recommends that CARB report additional information in its annual statewide greenhouse gas inventory to give context about the emission reduction trends needed to achieve its statutory and Scoping Plan targets.

Affordability. The second chapter addresses two sides of affordability. California households are forcefully affected by the changing climate through reduced labor productivity and agricultural yields, increased property damage, escalating wildfire risk, and more. Further, households pay for the costs of policy to reduce emissions of greenhouse gases. Californians with the fewest resources are the most vulnerable to both climate change impacts because they have fewer resources to adapt and respond, and to policy costs because they spend a larger share of their income on energy.

How we choose to pay for climate change mitigation and adaptation will determine, to a significant extent, how cost effectively and equitably we make the climate transition. This report elevates two affordability imperatives: cost containment and equitable cost allocation. Where it is possible to do so, overall costs of meeting emissions reduction targets can be lessened by placing a stronger reliance on the GHG emissions market and reducing the reliance on prescriptive regulation. Nonetheless, regulations often have a justification, and market outcomes can be better aligned with regulations by reducing allowance supply in the market in response to emissions reductions achieved by regulation.

Reducing allowance supply is key to achieving the ambitious emissions goals in the 2022 Scoping Plan. How the reduction is implemented will affect the share of allowance value that is distributed for free to utilities and industry and the share that accrues to the Greenhouse Gas Reduction Fund. The ongoing program review provides CARB with an opportunity to review the role of these channels for distributing allowances to ensure that each serves its intended purposes.

Market links. The third chapter addresses opportunities to link the carbon market with other jurisdictions. Even as California has played an important leadership role on climate policy, the state alone cannot reverse climate change nor ensure the livelihood and health of California residents. Those outcomes depend on national and global action. Successful climate policy in California requires the fulfilment of AB 32's directive to provide policy leadership nationally and globally. Linking carbon markets provides one avenue in this direction.

Market links have played a prominent role in carbon markets around the world. California's market is already linked to a similar program in Québec and was previously

linked with an earlier program in Ontario; other leading programs, such as the east coast states' Regional Greenhouse Gas Initiative and the European Union's Emissions Trading System, are also multilateral efforts that feature links between individual jurisdictions' carbon markets.

California is likely to have the opportunity to explore linkage with Washington state's new carbon market, and its eleven years of experience operating a carbon market is likely to serve as a key point of reference for policymakers in other states, such as New York. A market link is one of the ways the state can exhibit climate policy leadership and collaborate with other jurisdictions, similar to the work California has done in designing standards for energy efficiency, mobile source emission regulations, and clean energy policies that are frequently copied and modified by other governments. Cooperation is particularly important as California and a handful of other climate leaders — including Washington state, Canada, and the European Union — have made carbon pricing a central pillar of their climate policy portfolios.

Subsurface carbon management. The fourth chapter addresses point-source carbon capture and storage (CCS) technologies and a subset of carbon removal technologies such as direct air capture (DAC) that contemplate injecting captured CO2 underground. These technologies could play a significant role in reducing emissions and achieving California's 2045 carbon neutrality target, as well as increase investment in communities that have historically relied on the fossil fuel industry for economic development. At the same time, their deployment raises significant questions about their climate, social, and local environmental impacts. This chapter introduces some of the critical issues that face policymakers focused on these technologies. The IEMAC plans to continue working on these issues in 2024.

Greenhouse Gas Emissions Accounting

Danny Cullenward

Introduction

The California Air Resources Board (CARB) maintains three important accounting systems that track greenhouse gas emissions: the state's 1990 emissions baseline ("1990 baseline"), emissions data collected under its mandatory greenhouse gas reporting regulation ("MRR data") (CARB 2023a), and the statewide greenhouse gas inventory ("GHG Inventory") (CARB 2023b). These three systems play a critical role in the state's climate policy portfolio. Compliance obligations in the statewide cap-and-trade program are based on the MRR data, which also directly inform the GHG Inventory as of its 2022 Edition. Meanwhile, the GHG Inventory tracks the state's progress toward statutory emission reduction targets that are defined in relation to the 1990 baseline — reducing emissions below 1990 levels by 2020, at least 40% below 1990 levels by 2030, and at least 85% below 1990 levels by 2045.[1]

Because the 1990 baseline determines the overall level of state policy ambition and CARB uses the GHG Inventory data to measure progress toward state climate targets, it is important to understand how the state's greenhouse gas accounting systems are constructed and whether there are any opportunities to improve their consistency and accuracy. To that end, this chapter looks at how California's greenhouse gas accounting systems address four methodological issues: global warming potentials, biogenic CO_2 emissions, land sector emissions and removals, and a recent change to integrate the MRR data with the GHG Inventory. It then closes with a discussion and two technical recommendations.

Global warming potentials and CO_2-equivalence

Following convention and statutory guidance,[2] CARB reports the CO_2-equivalence (CO_2e) of emissions of multiple greenhouse gases across its accounting systems using global warming potentials (GWPs). The idea is straightforward: the CO_2e of a non-CO_2 greenhouse gas is determined by multiplying the number of tons emitted by that gas'

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[1] Health & Safety Code § 38550 (2020 target) (added by Assembly Bill 32 (Stat. 2006, Ch. 488)); *id*. at § 38566 (2030 target) (added by Senate Bill 32 (Stat. 2016, Ch. 249)); *id.* at § 38562.2(c) (2045 target) (added by Assembly Bill 1279 (Stat. 2022, Ch. 337)).

[2] *Id*. at § 38505(g) (defining "greenhouse gases" to include seven different species); *id*. at § 38505(c) (defining "carbon dioxide equivalent" as "the amount of carbon dioxide by weight that would produce the same global warming impact as a given weight of another greenhouse gas"); *id*. at § 38505(h) (defining "greenhouse gas emissions limit" in terms of carbon dioxide equivalent).

GWP. Like an exchange rate, a GWP makes it possible to quickly convert one gas (or currency) into another.

Technically, a GWP is calculated over a fixed time horizon by comparing the cumulative radiative forcing of two greenhouse gases over that fixed time horizon. In practice, most greenhouse gas inventories, including CARB's, use 100-year GWPs. For example, the 100-year GWP for methane (CH_4) is defined as the ratio between (1) the cumulative radiative forcing of one ton of CH_4 summed over 100 years and (2) the cumulative radiative forcing of one ton of CO_2 summed over 100 years. Perhaps the most prominent exemption to this general convention is New York's statutory requirement to use 20-year GWPs.[3]

When California began regulating greenhouse gas emissions, it was common to use 100-year GWPs published in the 1995 IPCC Second Assessment Report. CARB initially adopted the same approach and determined that 1990 statewide emissions were 427 million tCO_2e (CARB 2007a, CARB 2007b). As other regulators began to update their GWPs to reflect the best available science, CARB updated its estimate of 1990 emissions using 100-year GWPs drawn from the 2007 IPCC Fourth Assessment Report. CARB re-estimated 1990 emissions at 431 million tCO_2e, based on 2007 IPCC 100-year GWPs (CARB 2014a, CARB 2014b) — a modest increase of about 1% that reflected the higher GWPs reported by the IPCC.

Although the 1990 baseline and GHG Inventory adopted 2007 IPCC GWPs in 2014, the MRR data used 1995 IPCC GWPs through 2020. As of 2021, all three inventory systems consistently report CO_2e based on 2007 IPCC 100-year GWPs. Additional updates might be needed going forward, as the United States has committed to track its CO_2e emissions using 100-year global warming potentials from the 2013 IPCC Fifth Assessment Report (U.S. EPA 2023: ES-3).

Biogenic CO_2 emissions

Burning fossil fuels releases CO_2. CO_2 is also emitted when combusting biomass, such as wood waste or crop residues. But across California's greenhouse gas accounting systems, CO_2 emissions are treated differently depending on whether they derive from fossil fuels or biogenic sources: fossil CO_2 emissions are "included," while biogenic CO_2 emissions are "excluded." Excluded biogenic CO_2 emissions are still reported to CARB, but CARB does not include them as a liability in the cap-and-trade program nor as part of its statewide emissions.

[3] New York Environmental Conservation Law § 75-0101 [4] (defining "carbon dioxide equivalent" as "the amount of carbon dioxide by mass that would produce the same global warming impact as a given mass of another greenhouse gas over an integrated twenty-year time frame after emission.").

As climate policy scholar Leehi Yona explains, the special treatment afforded to biogenic CO_2 emissions derives from a set of little-known 2006 IPCC guidelines developed for land-sector emissions (Yona et al. 2022, Yona 2023).[4] The standard argument for excluding biogenic CO_2 emissions from official greenhouse gas inventories is premised on the notion that biogenic CO_2 emissions re-release carbon that plants originally sequestered from the atmosphere, such that there is no net climate consequence. But scientists have long understood that the land-use and supply chain consequences of bioenergy and biomass production vary widely, such that the presumption of zero net emissions from all biofuels is inaccurate (Searchinger et al. 2009).

CARB's Low Carbon Fuel Standard (LCFS) reflects this understanding and uses lifecycle assessment methods instead of broad assumptions about biogenic CO_2 emissions. Under the LCFS, fuels sold in California are assigned a carbon intensity score, calculated as the total CO_2e per unit of fuel energy content. Consistent with the contemporary understanding of the climate costs and benefits of biofuels, LCFS carbon intensity scores are based on lifecycle assessment methods that account for carbon sequestration, production emissions, land use impacts, and combustion emissions.

For example, CARB estimates that the lifecycle emissions of conventional gasoline sold in California results in emissions of 100.82 gCO_2e/MJ fuel.[5] Meanwhile, CARB estimates that the average carbon intensity of a prominent gasoline substitute, ethanol, has emissions of just under 60 gCO_2e/MJ fuel (CARB 2024a: Figure 5a) — about 40% less than gasoline.

Although CARB calculates that ethanol reduces emissions by about 40% relative to gasoline in the LCFS program, it books the outcome in the GHG Inventory as though ethanol reduces emissions by 100% because the GHG Inventory excludes all biogenic CO_2 emissions. Booking a 40% reduction as a 100% reduction exaggerates its benefits by about 250%.

The accounting consequences of this practice are substantial. CARB's GHG Inventory shows that excluded biogenic CO_2 emissions — which are tracked, but not included in the statewide data used to measure compliance with California's greenhouse gas emission limits — rose 22.9 million tCO_2, from 24.8 million tCO_2e in 2000 to 47.7 million tCO_2e in 2021 (CARB 2023b). Transportation fuel suppliers, who are the entities responsible for most biofuel-related emissions, reported that their excluded biogenic

[4] The GHG Inventory included biogenic CO_2 emissions until its 2016 Edition.

[5] California Code of Regulations, Title 17, § 95488.5 (Table 7-1).

CO_2 emissions rose 16.4 million tCO_2, from 8.7 million tCO_2 in 2012 to 25.1 million tCO_2 in 2022 (CARB 2023a).[6]

Land sector emissions and removals

Biogenic CO_2 emissions aren't the only excluded category of greenhouse gas emissions that are reported but not included in key California accounting systems. The other major category of excluded emissions comes from the land sector, often called AFOLU (agriculture, forestry, and other land use) in international climate policy circles.[7]

Land sector emissions can be difficult to estimate and are frequently controversial. They have recently re-emerged in California climate policy debates after the record-breaking 2020 and 2021 wildfire seasons, which CARB projects caused emissions of 106.7 and 85.1 million tCO_2, respectively (CARB 2022b: Figure 2). Although CARB published a separate Natural and Working Lands Inventory (CARB 2018), neither those data nor the wildfire emissions are included in the GHG Inventory and therefore neither is used as a basis for evaluating California's progress in reducing statewide emissions.[8]

However, CARB's 1990 baseline emissions include both emissions from and sequestration in the land sector, which CARB estimated resulted in a net sink of about 6.7 million tCO_2 (CARB 2007a: Table 2). Thus, although the GHG Inventory does not include land sector emissions or atmospheric removals, the 1990 baseline does.

Integrating the MRR data and the GHG Inventory

In 2022, CARB made a substantial change to the methodology used to calculate the GHG Inventory (CARB 2022a: 5). Previously, the MRR data were one of many sources used to inform the GHG Inventory, but CARB now describes the MRR data as the "primary" source used today (CARB 2023b: 36). These changes produced a substantial change in California's historical emissions, which CARB has retroactively updated to reflect the latest GHG Inventory methods, consistent with longstanding practice.

Figure 1 shows the change in the GHG Inventory data from comparing the most recent 2023 Edition (CARB 2023b) against the 2021 Edition, which was the last version

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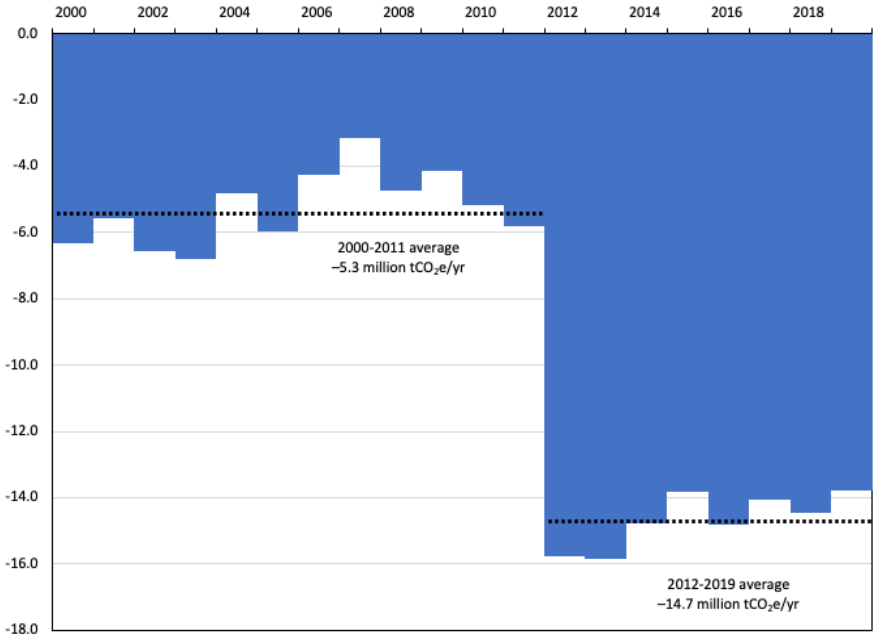
6 As explained further below, the MRR program began to collect full-scope data beginning in 2012, whereas the GHG Inventory includes projections back to 2000. MRR data are lagged by about one year, and thus 2022 data are the most recent as of this writing; in contrast, GHG Inventory data are lagged by about two years, and thus 2021 data are the most recent as of this writing.

7 California's GHG Inventory also tracks but excludes other emissions sources, such as international air travel and marine shipping. These sources are deemed international bunker fuels and their emissions are separately regulated by international treaties.

8 Land sector emissions are not included in the MRR data, although they are part of the cap-and-trade program, in which about 208 million tCO_2 in forest carbon offsets have been issued (CARB 2024b).

published before the decision to rely more directly on MRR data (CARB 2021). Two results are notable. First, reported emissions fell substantially across the entire historical period. Second, the pattern of changes exhibits a discontinuity in the year 2012. The bifurcation reflects the lack of full-scope MRR data prior to 2012; due to these limits, CARB's GHG Inventory methods rely primarily on MRR data only beginning in emissions in calendar year 2012 and afterwards (CARB 2022a).

Figure 1: Change in GHG Inventory, 2023 Edition vs. 2021 Edition (million tCO_2e)



For the earlier period in which MRR data are not available (2000 through 2011), CARB's current estimate of statewide emissions fell by an average of 5.3 million tCO_2e each year. And for the later period in which MRR data are available (since 2012), CARB's current estimate of statewide emissions fell by an average of 14.7 million tCO_2e each year.

The impact of these changes is substantial, both in terms of the lower emissions now reported in the GHG Inventory and because the methodological changes have not yet been applied to re-estimate the 1990 baseline. The premise of CARB's methodological update is that the MRR data are more accurate and reliable, in part because the MRR program requires third-party verification and has been subject to extensive refinement over more than a decade (CARB 2022a). Because California's greenhouse gas emissions limits are expressed relative to the 1990 baseline, however, changing the GHG Inventory methods without updating the 1990 baseline can reduce the stringency of state climate policy targets.

Specifically, if the 1990 baseline is artificially high, which is implied by the substantial reduction in the GHG Inventory observed since adopting the MRR data as its primary source, then the emissions limits may be similarly biased because the emission limits

are expressed as reductions relative to the 1990 baseline. This would result in a *de facto* weakening of statewide greenhouse gas emission limits (IEMAC 2022: 32-34). If such an outcome has occurred, it could be remedied by re-estimating the 1990 baseline.

Discussion

A comparison of four methodological issues common across three California greenhouse gas accounting systems illustrates some of the challenges facing climate regulators, as well as opportunities to improve the consistency and accuracy of reported outcomes (see Table 1).

Table 1: Greenhouse gas accounting issues in California

Methodology	**1990 Baseline**	**MRR data**	**GHG Inventory**
Global warming potentials used?	2007 IPCC GWPs (beginning in 2014)	2007 IPCC GWPs (beginning in 2021)	2007 IPCC GWPs (beginning in 2014)
Biogenic CO_2 emissions included?	No	No (Yes before 2016)	No
Land use emissions and removals included?	Yes	No	No
Based on current MRR data?	No	Yes	Yes

Two of the methodological issues are treated consistently across the three accounting systems. As of 2021, the 1990 baseline, MRR data, and GHG Inventory all use common 100-year global warming potentials drawn from the 2007 IPCC Fourth Assessment Report. Similarly, as of 2016, all three accounting systems exclude biogenic CO_2 emissions.

Although the choice of global warming potentials and biogenic CO_2 emissions are now consistently addressed across the three accounting systems, the resulting outcomes are not as accurate as they could be. When it comes to global warming potentials, the differences are not likely to be particularly large due to the relatively modest changes in GWP metrics across the 2007, 2013, and 2021 IPCC reports (U.S. EPA 2023: Table 1-

3). In contrast, excluding biogenic CO_2 emissions has much more significant consequences. Notably, the GHG Inventory does not capture the lifecycle emissions CARB assigns to the growing quantity of biofuels credited under the Low Carbon Fuel Standard.

Meanwhile, the third and fourth methodological issues illustrate significant inconsistencies. Although neither the MRR data nor the GHG Inventory include land-sector emissions and removals, the land sector was included in the 1990 baseline as a net sink of about 6.7 million tCO_2. More recently, CARB's decision to integrate the MRR data and GHG Inventory programs substantially reduced emissions reported in the GHG Inventory by about 14.7 million tCO_2e in each year. Although there are good reasons to believe this methodological update has significantly increased the accuracy of reported statewide emissions, the large changes it caused in the GHG Inventory suggest that the 1990 baseline may need to be reviewed for consistency.

Finally, however CARB determines California's 1990 baseline and reports progress toward statutory greenhouse gas emission limits in the GHG Inventory, it would help to provide additional context on the pace of observed emission reductions and trends needed to achieve policy targets going forward.

For example, the GHG Inventory reports that 2021 emissions were 381.3 million tCO_2, down about 23.1 million tCO_2 since 2019 (or about 11.5 million tCO_2 per year since 2019) (CARB 2023b). Furthermore, based on the reductions reported in the final 2022 MRR data, CARB projects preliminary 2022 GHG Inventory emissions of 370.4 million tCO_2, or an additional 10.9 million tCO_2 reduction from 2021. These data represent good news that reflect well on the efforts CARB and other policymakers have made to reduce emissions. Nevertheless, it is difficult to interpret the meaning of these accomplishments without additional context about what is required to meet California's climate targets.

To help give additional context, Table 2 and Table 3 report the annual reductions required to achieve California's minimum 2030 climate target (40% below 1990 emissions)[9] and the higher ambition target identified in the 2022 Scoping Plan (48% below 1990 emissions),[10] based on the official 2021 data and preliminary 2022 projections from the GHG Inventory, respectively (CARB 2023b). These tables show that a reduction of 10-12 million tCO_2 per year is close to but still below the pace needed to realize the statewide emissions limit set by Senate Bill 32 (about 13-14 million tCO_2 each year) and significantly below the pace required to realize the emission

[9] Calculated here as 60% of CARB 1990 baseline estimate (431 million tCO_2e), 258.6 million tCO_2e.

[10] Based on the total gross emissions projected in 2030 for the 2022 Scoping Plan scenario, not including gross carbon dioxide removals (CARB 2022c), 226.3 million tCO_2e.

reductions contemplated by the 2022 Scoping Plan (about 17-18 million tCO_2 each year).

Table 2: Annual reductions needed through 2030, based on official 2021 data (units: million tCO_2)

Scenario	2030 Target	2021 emissions (official data)	Annual Reductions Needed
Senate Bill 32 40% below 1990	258.6	381.3	–13.6
2022 Scoping Plan 48% below 1990	226.3	381.3	–17.2

Table 3: Annual reductions needed through 2030, based on preliminary 2022 projections
(units: million tCO_2)

Scenario	2030 Target	2022 emissions (projection)	Annual Reductions Needed
Senate Bill 32 40% below 1990	258.6	370.4	–14.0
2022 Scoping Plan 48% below 1990	226.3	370.4	–18.0

Recommendations

1. CARB should evaluate the four accounting issues discussed in this chapter — the choice of global warming potentials, the treatment of biogenic CO_2 emissions, the inclusion of land-sector emissions and removals, and the integration of the MRR data into the GHG Inventory — to determine if there are ways to more consistently and accurately report greenhouse gas emissions and removals

across its 1990 baseline estimate, MRR data, and statewide GHG Inventory.

2. As part of its annual GHG Inventory update, CARB should report the average annual pace of emission reductions across the emissions included in its GHG Inventory that would be required to meet all statutory targets (e.g., 40% below 1990 emissions by 2030) as well as any higher levels of ambition CARB adopts in Scoping Plans or similar documents (e.g., the 48% target identified in the 2022 Scoping Plan).

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Affordability and the Climate Transition

Meredith Fowlie and Dallas Burtraw

California is on the front lines of the climate crisis. Extreme heat, drought, rising sea levels, and escalating wildfire risk are significantly impacting the health, safety, and well-being of all Californians. These climate impacts are imposing large economic costs through multiple channels (e.g. reduced labor productivity, reduced agricultural yields, and property damages). Moreover, these costs are not equally distributed. Californians with the fewest resources are the most vulnerable to these climate change impacts.

Avoiding the most damaging effects of climate change will require significant investment in economy-wide decarbonization. This includes investments in new renewable energy generation; electricity transmission and distribution infrastructure; the electrification of transportation, buildings, and some industrial sectors. Adapting to climate change impacts will also require large investments in wildfire risk mitigation, disaster preparedness, flood controls, and other adaptation strategies.

As California confronts both the formidable costs of unmitigated climate change, and the formidable costs of slowing the pace of climate change, concerns about affordability and equity loom large. The 2022 Scoping Plan notes:

An important part of our equity consideration is ensuring the transition to a zero-emission economy is affordable and accessible, and that it uplifts disadvantaged, low-income communities and communities of color. Some aspects of the transition will have associated costs (e.g., escalating efforts to retrofit existing homes and businesses to support electric appliances and vehicles and increased costs of insurance). The state must ensure that these costs do not disproportionately burden consumers.

Low-income households will be disproportionately burdened if California does not change how we pay for climate change adaptation and mitigation investments. A recent increase in California's retail electricity prices provides an important case in point. Residential customers of California's largest utility recently saw that their monthly utility bills will increase by $34.50 (on average) in 2024. Two key drivers of this increase: massive investments in wildfire risk mitigation (a form of climate change adaptation) and a growing "cost shift" caused by net energy metering incentives for rooftop solar PV customers.[11]

This practice of increasing retail electricity prices above the social marginal cost of providing electricity services to pay for non-incremental costs (such as wildfire risk

[11] The January 2024 Electric Rates Report issued by the Public Advocates Office at the CA Public Utilities Commission lists wildfire mitigation and rooftop PV solar incentives among the top three drivers of retail electricity rate increases statewide. https://www.publicadvocates.cpuc.ca.gov/-/media/cal-advocates-website/files/press-room/reports-and-analyses/240119-caladvocates-q4-2023-quarterly-rate-report.pdf

mitigation) will slow our progress on electrification. Importantly, it is also inequitable. Rising electricity prices impact low-income households disproportionately because these households spend a relatively greater share of their income on direct energy use for electricity, gasoline, and home heating (Borenstein, Fowlie, and Sallee, 2022).

How we choose to pay for climate change mitigation and adaptation will determine, to a significant extent, how cost effectively and equitably we make the climate transition. The severe risks posed by climate change warrant significant investments in mitigation and adaptation. As the costs of mitigating and adapting to climate change increase, policymakers must work to contain these costs and allocate them judiciously.

The directive of this Committee is to report on the design and performance of California's greenhouse gas (GHG) emissions market. In what follows, we discuss the role of GHG market with respect to these two affordability imperatives: **cost containment** and **equitable cost allocation**.

Cost Containment

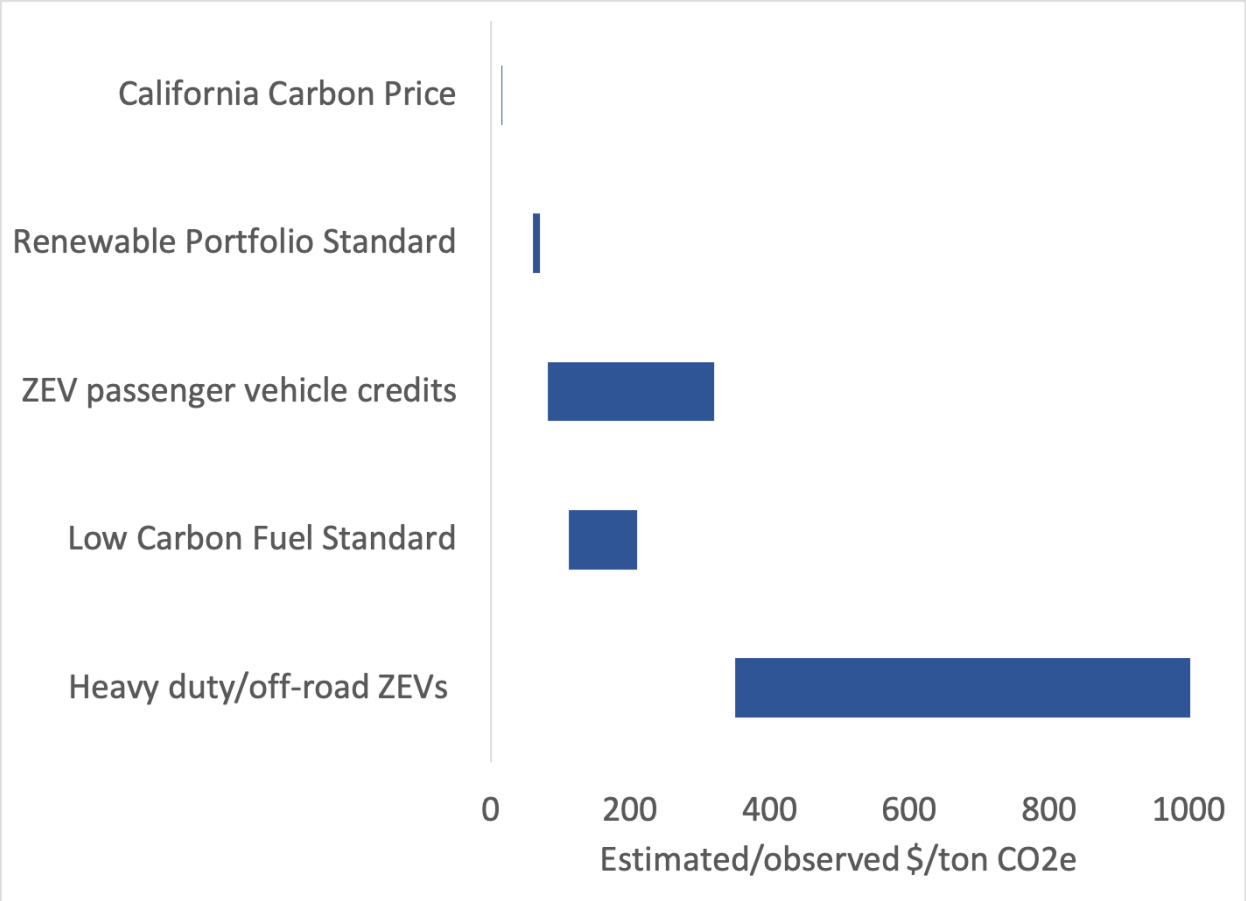
California climate policy makers are using emissions pricing, in combination with direct regulation, to achieve our GHG abatement goals. In previous reports from the Committee, and again in discussions this year, a recurring theme has been how to improve the alignment of prescriptive regulations with the GHG emissions market to improve cost effectiveness and to amplify the effectiveness of each.

California's market based GHG emissions trading program offers some important cost advantages relative to prescriptive regulation. Under a cap-and-trade program, regulated firms must acquire and surrender tradeable allowances to offset their GHG emissions. The compliance flexibility enabled by a GHG allowance trading system provides an incentive for regulated entities to seek out and deploy least-cost GHG emissions abatement strategies, including those that are not visible or known to the regulator when the policy is implemented. A related advantage of this more flexible approach: the GHG market can flexibly deploy abatement strategies in a way that leverages technological innovations and responds to changes in economic activity, weather events, etc.

California has historically relied more heavily on prescriptive, sector-specific regulations, versus the GHG market, to deliver GHG emissions reductions. These include regulations promoting vehicle fuel efficiency, renewable energy investments, etc. Sometimes these regulations are justified by the intent to drive innovation or overcome technology adoption coordination failures. However, a strong reliance on prescriptive approaches can increase the overall cost of meeting our GHG abatement targets if the prescriptive approaches target relatively costly GHG abatement options.

The cost per ton of CO2e emissions avoided is one coarse metric which can be used to compare climate change mitigation strategies and associated programs. The graph below

compares an assortment of estimated cost-per-ton-of-GHG-abated (some marginal, some average) for some key California programs:



Notes: This graph illustrates comparisons across programs at different points in time drawing from the following sources: GHG allowance prices (2018-2020) are reported here. LCFS prices (2018-2020) are reported here. Cost estimates for the RPS in 2018 are from this LAO report. Cost estimates for the ZEV credit program are estimated here. Cost estimates for heavy-duty ZEVS are from this LAO report (other ZEV program costs estimated in this report are off the chart).

The graph shows that the estimated cost-per-ton CO2e abated under some prescriptive California programs have at various times significantly exceeded what we've been paying for GHG abatement in the emissions market. Table 3-11 from the Scoping Plan also estimates high abatement costs for some measures considered in the Scoping Plan Scenario (e.g. building electrification). Mandating expensive GHG abatement measures when emissions allowance prices are relatively low could significantly increase the costs of meeting our CO2e abatement targets. Put differently, a well-functioning GHG market has a critical role to play in our cost containment efforts.

A stronger reliance on the GHG emissions market to deliver cost-effective abatement could significantly reduce the overall costs of meeting our GHG emissions reduction targets. But this would require policy changes that would tighten the GHG market and thus increase the market clearing GHG allowance price. The structure of the supply schedule for introducing allowances into the market with a price floor and a series of price steps - price-responsive allowance supply – is expected to reduce price volatility and assure compliance entities that they will have access to allowances in a tight market. Additional price steps, including an emissions containment reserve, could further improve integration of prescriptive regulations with the GHG allowance market by harvesting emissions reductions achieved by direct regulation to ratchet down allowance supply.

Cost Allocation

Roughly half of California's GHG market emissions allowances enter the market through a revenue-raising auction with proceeds going to the Greenhouse Gas Reduction Fund. The other half of the allowance supply is freely distributed to industry to protect competitiveness, mitigate emissions leakage, and benefit ratepayers (in the case of utilities). How these allowances are allocated, and how auction revenues are used, has potentially significant implications for cost allocation. A potential update to the design of California's GHG market provides an opportunity to re-evaluate the distributional implications of free allocation, and the protocols guiding the use of the GGRF funds.

As part of its ongoing workshop process to update the GHG market and align it with the with the state's more ambitious climate policy goals reflected in the 2022 Scoping Plan, CARB is considering an adjustment to the supply of allowances, which is likely to increase the GHG market allowance price. We are already observing price movements consistent with anticipation of a more stringent cap. Since the first quarter of 2021, with the pandemic recovery, completion of the Scoping Plan process, and the initiation of workshops to consider updates to the GHG market, the allowance price has increased 117%.[12] This increase in price maps into an increase in the value of banked allowances held in private hands.[13] We expect that reducing the supply of allowances will likely cause further increases in the allowance price.[14] Depending on how the allowance supply is adjusted, this increase in value will accrue to the Greenhouse Gas Reduction Fund and/or the million recipients of free allocations.

If the reduction in allowance supply is implemented primarily through a reduction in allowances allocated to industry, the increase in the allowance price will cause proceeds to the Greenhouse Gas Reduction Fund to increase. How these funds are allocated is a

[12] The auction clearing price in the first quarter of 2021 was $17.80 and for the fourth quarter of 2023 it was $38.73 (nominal dollars).
[13] The value of over 300 million privately held (banked) allowances have increased by more than $6 billion (nominal dollars).
[14] The effect of limiting allowance supply on the asset value of allowances depends on the elasticity of allowance demand. Borenstein et al. 2019 find allowance demand to be relatively inelastic especially in the short run. Burtraw et al. 2022 arrive at a similar finding in modeling the electricity sector.

policy decision ultimately shaped by the legislature. Using these funds to reduce the cost burden borne by low-income households and communities could offer an important way to advance our overarching equity and affordability goals.

Alternatively, if reductions in allowance supply are implemented primarily through a reduction in auctioned allowances, a greater share of the allowance value increase will flow into free allocations. The distributional impacts of this approach will depend significantly on how GGRF expenditures are impacted and which of the industry or utility allocations are preserved. California's GHG emissions market reform thus presents an important opportunity to re-evaluate how allowance value is being distributed to ensure that allowances are being allocated judiciously and in line with affordability/equity objectives.

Recommendations

1. A well-functioning GHG emissions market has a critical role to play in identifying least cost abatement options and containing the overall cost of meeting GHG targets. The role of the GHG market should be maintained and expanded over time.
2. Cost-containment and equitable cost allocation should be guiding principles of California's GHG market design, reform, and implementation.
3. Allowance supply changes will be needed to bring the GHG market in line with California's increasingly ambitious GHG targets. How these supply adjustments are implemented will impact how future GHG abatement costs are allocated across households and firms. These adjustments should be evaluated according to the guiding principles we describe.
4. Free allowance allocations to industry and the designated use of free allocation to utilities should be reviewed judiciously to ensure that these allocations are serving their intended purpose.

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Propagating California's Program Success and the Vision of AB32 through Program Linking

Katelyn Roedner Sutter and Dallas Burtraw

California is rightly proud of its world-leading efforts to address climate change, but greenhouse gas emissions and even air pollution do not respect state borders. Furthermore, California emits only approximately 1% of global greenhouse gas emissions. However, a similar effect is true for emission reductions – the benefits of California's success spill over into other jurisdictions. While efforts to reduce climate pollution within the state are essential to meeting our greenhouse gas reduction goals, often the even greater value is in exporting our innovations in climate and air quality to other jurisdictions to maximize reductions. California's leadership in policy design and technology development provides global benefits. To maximize the value of these efforts, California should not remain passive and should indeed encourage the propagation of its climate and technology policies.

The state's seminal Global Warming Solutions Act of 2006 (AB32) accelerated the state's tradition of environmental leadership and placed it at the forefront of national and international efforts to reduce emissions of greenhouse gases. Acknowledging that national and international efforts are necessary, the Act calls for California's actions to have far-reaching effects by encouraging other states, the federal government, and other countries to act. These actions by other jurisdictions have positive feedback effects for California that have been documented extensively elsewhere, such as:

- Creating new economic opportunities for California's clean energy technology and economy;
- Reducing the specter of emissions leakage and economic activity to businesses in unregulated jurisdictions;
- Improving regional air quality;
- Aligning the regulatory environment for business;
- Improving administrative, monitoring, and enforcement activity;
- Influencing climate policy development at an ever-broadening scale; and
- Most importantly, driving emission reductions to slow the impending environmental crisis.

Many transformational climate policies developed in California have been adopted in other jurisdictions including vehicle efficiency standards enabled under the federal Clean Air Act, clean energy and storage policy directives, and energy efficiency

standards. Notably, Quebec has a cap-and-trade program like California's, which enabled early linking of the two markets under the Western Climate Initiative (WCI) to maximize emission reductions. State agencies have a history of generosity in sharing insights into the state's policy experiences in all these areas. However, the propagation of emissions caps has been slower than proponents of AB32 would have hoped or anticipated.

Linking the California and Quebec carbon market with additional jurisdictions would yield numerous benefits for each jurisdiction including the opportunity for greater emission reductions, easing the administrative burden of program implementation, potentially lower cost of compliance for covered entities, and the less-tangible but essential momentum for climate action. California has a well-thought-out framework for regulation and enforcement of the carbon market that can serve as a model for other jurisdictions. CARB might look for opportunities to further build on its existing openness in sharing expertise with even greater technical assistance for other jurisdictions because the adoption of ambitious policies elsewhere and the emergence of a regional carbon market would benefit California.

In 2021, Washington State passed the Climate Commitment Act, which established an economy-wide cap-and-invest program. This program was created with the intention of future linkage with the California-Quebec market. Illustrating the depth of California's influence in policy design, Washington's program mirrors California's in key ways, making it likely a compatible partner for program linkage. Washington's Department of Ecology announced in November 2023 that they intend to pursue formal program linkage with the California-Quebec market, and the state legislature is currently considering a bill that would further align the Washington program with the WCI to facilitate a smooth linkage process. Given the strides Washington is making in aligning with California, and the urgent need to maximize greenhouse gas emission reductions, California should now initiate its own process for evaluating linkage.

By linking markets, California and Quebec can join forces with Washington to drive even greater climate progress through a broader and more stable regionally linked market. A bigger, linked market provides more opportunities for companies to identify lower-cost options to reduce their emissions, and the increased liquidity of a larger market provides greater insulation against price shocks and reduced volatility – whether those fluctuations are influenced by natural disasters or political conditions. A more stable regional market provides incentives for covered entities to invest in emissions abatement and provides greater confidence in the ability of all participating jurisdictions to achieve their climate goals at a time when multiple analyses show the importance of sub-national action to achieving climate targets.

California's leadership is needed to meet this moment – both in the state and across borders. California could be an active and proactive partner to the many states for which its policy is a model. In the near term, this could include expeditiously undertaking the

linkage evaluation process regarding Washington's program, and continuing conversations between agency staff and other policy leaders.

In addition to Washington's cap-and-invest program, the prospect of economy-wide carbon pricing is gaining momentum elsewhere; New York is in the process of finalizing the rules for its own cap-and-invest program, and Maryland is considering cap-and-invest as part of their Climate Pollution Reduction Plan. As these programs grow across the country, California's decade of experience in running an economy-wide carbon market is an invaluable source of knowledge – one that other states will need to tap into as they design their programs. When these programs become operational, California should prioritize exploring program linkage and seek out all opportunities for collaboration in the building and operation of compatible markets.

Recommendation

1. IEMAC calls for CARB to look for opportunities to expand its administrative and logistical support to jurisdictions developing or considering carbon limit policies, including but not limited to New York and Maryland; consider soliciting carbon limits and carbon pricing on a regional and national basis; and initiate its process for a linkage determination with Washington.

Subsurface Carbon Management

Brian Holt and Dallas Burtraw

CARB's 2022 Scoping Plan lays out an official pathway to achieve carbon neutrality within California. This plan and existing climate policy emphasize the prevention of greenhouse gas emissions as the dominant and preferred pathway to carbon neutrality. By most accounts, renewable energy resources with energy storage is the least-cost pathway to deep emissions reductions, but obstacles to the complete substitution away from fossil fuels remain. In addition, process emissions in industry remain a significant challenge. To achieve carbon neutrality, any remaining emissions after achieving maximal sectoral reductions through substitution away from fossil fuel will likely require add-on post-combustion technology at point sources such as natural gas power plants, biomass power plants and concrete plants to capture and concentrate carbon dioxide from flue gas and store it underground. The storage component primarily involves injection of CO_2 into geologic formations (such as depleted oil and gas reservoirs and saline formations), and to a small degree its use in industrial materials (e.g., concrete).

Carbon capture and storage (CCS) may also play a role in the application of technology to lessen the effect of prior legacy emissions. CCS may be coupled with direct air capture (DACCS) of carbon from the atmosphere to reduce atmospheric concentrations. When biomass is used for electricity production and coupled with CCS (BECCS), it can yield negative emissions if the captured emissions are greater than the net emissions from bioenergy combustion, the energy used to capture and inject flue gas CO_2, and the complex dynamics of land use and land opportunity costs. Because bioenergy with CCS involves the combustion of biomass that regrows over time, its physical climate impact is characterized by emissions upfront that are reduced by CCS and climate benefits that accrue over time. Other examples of technologies that may yield negative emissions involve the development of carbon sinks in soils and forests, production of biochar, biochemical processes in oceans and enhanced chemical weathering of rock.

The focus of this chapter is on CCS as applied to emissions reductions at emitting facilities. As mentioned above, CCS is directly relevant to some approaches to carbon dioxide removals from the atmosphere, and recent legislation (SB 905) comingles directives to CARB for development of a unified framework for subsurface carbon management for captured emissions and direct air capture. Consequently, this chapter also has relevance to a subset of carbon removal technologies that involve subsurface carbon management.

Possibilities

The 2022 Scoping Plan shows that CCS at industrial and electricity generating facilities is anticipated to capture 13 $MMTCO_2e$ by 2030 and 25 $MMTCO_2e$ by 2045. Carbon dioxide removals at natural and working lands, DACCS, and BECCS are expected to

total 7 $MMTCO_2e$ in 2030 and 75 $MMTCO_2e$ by 2045. Governor Newsom has recognized the importance of strategies for CO_2 capture at industrial facilities and removal from the atmosphere. The Governor directed CARB to accelerate development of natural and engineered carbon removal and carbon abatement projects with a CO_2 target of 20 $MMTCO_2$ for 2030 and 100 $MMTCO_2$ for 2045, as well as signing 2022 legislation on carbon abatement and removal and storage, including: AB 1279, SB 905, and SB 1137. Related legislation (AB 1757) addresses carbon sequestration in natural and working lands.

CCS projects have been implemented at various locations since the 1970s, largely on coal-fired power plants, with over two dozen projects operational around the world. As of November 2019, more than half of global large-scale CCS facilities (representing approximately 22 $MMTCO_2$/yr in capacity) were in the U.S., mostly due to sustained governmental support for these technologies. Over 100 projects are at the stages of advanced or early development and are expanding beyond coal-fired plants to fossil gas, fuel production, and electricity generation facilities.

In California, subsurface carbon management presents opportunities for economic development in industries and communities that are subject to the greatest losses from the energy transition away from fossil fuels. California's deep sedimentary rock formations in the San Joaquin Valley represent world-class CO2 storage sites that would meet the highest standards, with storage capacities of at least 17 billion tons of CO2.

There are seven cement plants operating in California currently. These plants have emissions associated with combustion and process-related activities. Combustion emissions account for 30-40 percent of the total emissions at cement plants, with the remaining emissions are related to process-related activities (Rissman et al. 2020). Cement is a good candidate for CCS due to the high temperature processes needed to produce cement, although high temperature electric heat and non-fossil hydrogen may soon provide feasible alternatives to combustion. SB 596 calls for a 40 percent reduction in GHG intensity in cement emissions from 2019 levels by 2035, and then net zero emissions by 2045. To meet in-state demand, the state relies on cement both produced in the state and imported. Additional reductions will need to be pursued and considered as part of implementation of SB 596, which directed CARB to develop a comprehensive strategy for the state's cement sector, and to achieve net-zero emissions of greenhouse gases associated with cement used within the state as soon as possible, but no later than December 31, 2045.

Currently, there are seventeen petroleum refineries operating in California. Despite ambitious emissions reductions at refineries described in the Scoping Plan, and implementation of Executive Order N-79-20 that precludes the sale of new emitting vehicles by 2035, there will remain some demand for petroleum fuels for legacy vehicles on road applications, and in aviation, rail, and marine applications. Petroleum refineries will need to implement technology to decarbonize their operations and reduce their

emissions. The Scoping Plan assumes CCS at petroleum refineries as one of those potential strategies, although only a small number of these sources may be technically amenable to continuous operation of CCS. Some advocates of carbon management anticipate that construction activity from a build out of CCS at existing and new facilities would contribute to the production of low carbon intensity hydrogen, transportation fuels, and electricity, although some experts would question what constitutes "low-carbon" hydrogen, potential leakage of methane and CO_2 capture rates.

Addressing Risks

Stakeholders have raised multiple concerns related to the inclusion of CCS and carbon dioxide removal in the Scoping Plan. One focus has been on potential negative health and air quality impacts in communities from operation of facilities utilizing CCS that continue to emit other emissions, especially in communities already overburdened by air pollution. Community-level concerns have also focused on safety concerns related to potential leaks of carbon dioxide from storage facilities.

Critics have also questioned the economic viability of the CCS and direct air capture carbon dioxide removal technology, suggesting that modeling and policy planning are misguided by including them in future scenarios. The economic viability of these technologies depends on policy support at the federal and state level. There has yet to be a comprehensive evaluation of technological impacts or identification of best practice and preferred policy pathways, especially with respect to carbon dioxide removals. The development of a unified policy framework mandated under SB 905 may take important steps in resolving this shortcoming.

Environmental advocacy stakeholder concerns also focus on the presumed moral hazard resulting by the focus on mechanical carbon management because it may enable continued fossil fuel use and delay investments in non-emitting technologies. Attention given to carbon dioxide removal, in particular, may deter mitigation by reducing the salience of climate change mitigation. This may be especially true if carbon dioxide removal substitutes directly for mandatory emissions reductions.

Industry stakeholders express uncertainty about the lack of understanding and clarity over the potential role for CCS in the cap-and-trade program. A protocol exists for the LCFS program, but uncertainty about is applicability to the carbon market introduces regulatory risk that is a barrier to project development.

These stakeholder concerns are already substantially covered under the scope of SB 905 and may be resolved with full implementation of the legislation, which we discuss below. Nonetheless, successful policy must address these concerns, including through the development of guardrails that define which types of carbon management projects are consistent with the state's climate goals as well as those that appropriately balance the economic development opportunities for and environmental risks to local communities.

Policy

Substantial government support for CCS and some forms of carbon dioxide removals from the atmosphere is in place at the federal and state level depending on the specific application and products. The Inflation Reduction Act provides tax incentives for the capture and sequestration of CO_2 in Section 45Q, although we note it is calibrated to gross CO_2 sequestration rather than net emissions reductions, providing imperfect incentives for efficient implementation. The Act incentivizes low-carbon hydrogen production under Section 45V with a lifecycle calculation that rewards low-carbon production. At the state level, CARB adopted a CCS Protocol in 2018 as part of amendments to the Low Carbon Fuel Standard that enables crediting of CCS projects for oil and fuels production under lifecycle pathway applications. At this time, no CCS projects have been credited under the LCFS protocol.

The next expected policy advances in facilitating carbon management in California will be implemented under SB 905, adopted in 2022, which directs CARB in consultation with other state agencies, to create a CCS program aimed at accelerating the deployment of carbon management technologies. Responsibilities for CCS in California are assigned to CARB, the California Natural Resources Agency, and California Geological Survey. Under SB 905, CARB must adopt regulations for CCS and technologies or strategies to remove CO_2 from the atmosphere and put it into long-term storage. CARB must also make available a permitting portal to allow project operators to submit all permit-related information through one online platform. SB 905 also requires California Natural Resources Agency to: 1) establish a framework for intrastate pipelines carrying carbon dioxide fluid and 2) to publish a framework for governing agreements for the purposes of managing carbon dioxide storage project reservoirs. The California Geological Survey is tasked with developing a Geologic Carbon Storage Group that will provide expertise and guidance on carbon storage.

There are various unresolved policy questions that are important for subsurface carbon management. For CCS to be applied to emitting sources covered under the cap-and-trade program, it would be valuable to clarify whether the CCS protocol applied to the LCFS is sufficient guidance for the cap-and-trade program. While some proponents feel the application is a straightforward extension of that protocol, others seek greater certainty including clarity about the liability for leakage and protocols to ensure permanence of carbon storage. Regulatory uncertainty, whether justified or not, will impede investment, and this uncertainty needs to be resolved before investments will occur.

There remain difficult questions about the role of mandates and additional incentives for carbon dioxide removals in California's policy framework that stretch beyond the framework that will be established under SB 905. The cap-and-trade programs' carbon price provides an economic incentive to reduce covered entities' CO_2 emissions and serves as a price point against which CCS could be economically justified. However, there are conflicting views on whether carbon dioxide removals should be given credit

as offsets in the cap-and-trade market and resolving this will be an important issue for CARB and the legislature. A different approach might involve the introduction of a new compliance obligation, analogous to a storage mandate or renewable energy mandate in the electricity sector, mandating a removal credit for each specified number of tons of emissions covered in the cap-and-trade market. Other approaches to introducing incentives or requirements are possible.

California policy makers have a chance to incentivize and shepherd the development of subsurface carbon management in a way that respects environmental integrity and community values. Discussions about how this is achieved should move to central stage in 2024.

Recommendations

1. The state should develop of guardrails that define which types of subsurface carbon management projects are consistent with the state's climate goals as well as those that appropriately balance the economic development opportunities for and environmental risks to local communities.
2. CARB should move to resolve and clarify the protocol for the application of CCS at emitting sources.
3. CARB and the legislature must clarify the incentives and/or mandates for application of carbon removals through direct air capture before such investments can take place.

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Individual statement of Vice Chair Danny Cullenward

I write to make two brief observations about the chapters on market linkage and subsurface carbon management, with thanks for my colleagues' contributions.

First, my colleagues have ably articulated how market links can help coordinate carbon pricing policies and share administrative capacity across cooperating jurisdictions. While I appreciate these important benefits, I would respectfully counsel greater modesty with respect to California's own experience with its carbon market as well as California's ability to help other jurisdictions navigate their own challenges. I am satisfied that Washington's carbon market is equally or more stringent than California's and hopeful that CARB's program reform workshops exhibit the potential to satisfy Washington's own statutory requirements for linkage as well. Furthermore, the history of linking and de-linking carbon markets in the Western Climate Initiative shows that it is possible to manage the risks and opportunities associated with cross-border market links. In my opinion, however, market links are not a particularly important category of climate policy cooperation in general, even if they can be highly relevant to individual jurisdictions and present minimal risks in specific contexts. Climate policy cooperation is extremely important and can be furthered through carbon market links, but it primarily occurs in other policy areas.

Second, I note that issues related to carbon capture and storage as well as atmospheric carbon dioxide removal are becoming ever more relevant, including after the passage of AB 1279, which set a net-zero target for California greenhouse gas emissions, and the approval of CARB's 2022 Scoping Plan, which outlined a scenario for achieving that target. I appreciate the potential for carbon capture technologies to mitigate truly hard-to-abate greenhouse gas emissions, a category of emissions that in my judgment appears to shrink every year as technology progresses and new policy efforts are applied. I am also mindful that carbon capture and storage technologies can present risks to local communities, impacts to local air and water quality, and even impede the broader cause of climate mitigation, as the improper deployment of carbon capture technologies can delay or disrupt emission reductions and arguably has already done so in the 2022 Scoping Plan. Because the IEMAC has not held a public meeting to discuss these issues, I consider this year's chapter on subsurface carbon management as an introduction, not the final word, and appreciate my colleagues' thoughtful engagement. I remain committed to addressing these topics in the year ahead with the attention to detail their complexity requires.