



**CALIFORNIA CARBON MARKET COLLABORATIVE
COMMENT LETTER TO CARB
15 DECEMBER 2023**

Re: California Carbon Market Collaborative Comments on CARB’s Informal Workshop on Potential Amendments to the Cap-and-Trade Program

The California Carbon Market Collaborative (CCMC) appreciates the opportunity to provide public comment on the California Air Resources Board’s (CARB) informal workshop on potential amendments to the Cap-and-Trade (C&T) Program held on 16 November 2023. This comment letter should be read together with our letters submitted to CARB on 17 August 2023 and 26 October 2023.

Elevate Climate convenes the CCMC in support of the design and implementation of an ambitious and equitable California C&T Program through 2045 and beyond. The CCMC gathers a wide array of C&T stakeholders to deepen mutual understanding and undertake careful examination of key Program design features. Participants of the CCMC include Environmental Defense Fund, Liminality Capital LP, and Pacific Gas & Electric.

In summary, the CCMC reiterates its emphasis on ambition as CARB updates California’s C&T Program. As detailed in Section 1, the modeling results clearly indicate that extending the C&T Program beyond 2030 is the simplest way to enhance ambition. As discussed in Section 2, the C&T Program achieves highly cost-effective emission reductions. Therefore, further reliance on carbon markets facilitates the cost-effective achievement of California’s ambitious climate targets and should invite California to do more. In addition, crafting a more ambitious C&T Program that accounts for and incentivizes climate technologies will supercharge California’s ability to leverage the unprecedented funding available through the Inflation Reduction Act to build new in-state infrastructure that reduces GHG emissions.

As outlined in Section 3, the CCMC argues the modeling results presented by UC Davis should be updated before being used to inform changes to the C&T Program. We identify a number of serious concerns around the modeling approach and underlying assumptions which critically undermine the reliability of UC Davis’s allowance price projections. Each of these concerns should be directly addressed in a subsequent round of economic modeling presented at another CARB public workshop.

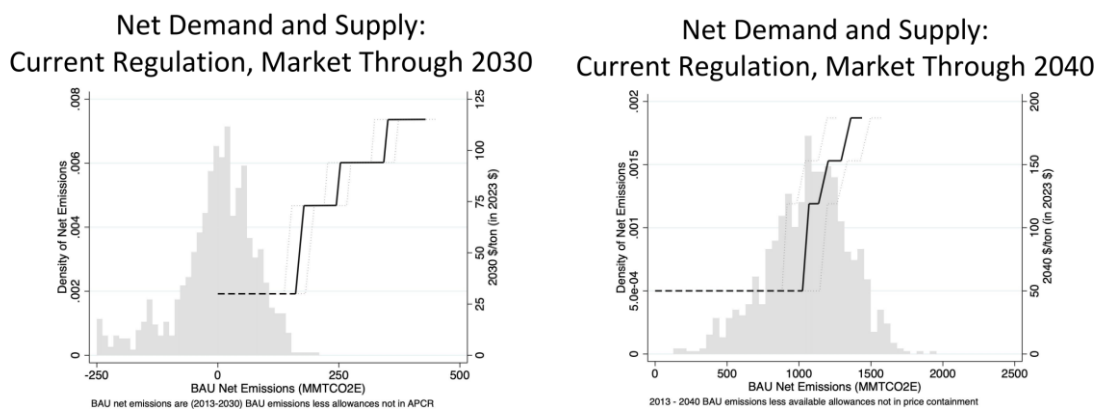
As discussed in Section 4, the CCMC expresses unambiguous support for maintaining the current joint market rules as they pertain to the banking of allowances. Allowance banking is a fundamental aspect of C&T Programs that incentivizes regulated entities to reduce GHG emissions sooner than they would otherwise, thereby providing substantial environmental benefits.¹ Section 4 summarizes a number of case studies illustrating that a wide range of climate policies underperform when the regulator does not allow unlimited banking.

¹ Leard, Benjamin. 2013. “The Welfare Effects of Allowance Banking in Emissions Trading Programs.” *Environmental and Resource Economics* 55: 175-197.

1. The CCMC Applauds CARB for its Post-2030 Scenarios

The CCMC agrees with Dr. Bushnell from UC Davis that “the single biggest impact California can have to encourage abatement through its cap and trade [program] is committing to the program beyond 2030”.² Dr. Bushnell’s point is clearly communicated in Slides 28 and 29 of the November 16 Workshop Combined Presentation, excerpted below. By simply extending the C&T Program from 2030 to at least 2040, net demand for allowances transitions from falling behind to significantly outpacing allowance supply in expectation.

Figure 1
Net Demand and Supply With and Without C&T Program Extension Beyond 2030
Source: UC Davis Presentation, November 16 CARB Workshop



As the CCMC mentions in previous public comment letters to CARB, an uncertain future for the C&T Program leads to uncertainty for project developers who may not see the value or benefit from GHG emission reductions they create beyond 2030. Extending the C&T Program beyond 2030 ends that uncertainty and therefore sends a strong signal to compliance entities and infrastructure investors to reduce GHG emissions. The CCMC applauds CARB for its continued consideration of a number of Scenarios and Options extending well beyond 2030.

2. A Unique Opportunity for the C&T Program to Supercharge Decarbonization Projects

The CCMC reiterates that California has a unique opportunity with the C&T rulemaking to supercharge decarbonization projects into California that create jobs and reduce GHG emissions by combining the following:

- A high ambition cap trajectory (at least a 48% Scenario) selected during the ongoing rulemaking;
- A C&T Program updated through the ongoing rulemaking that accounts for and/or incentivizes a wide array of climate technologies; and,

² Bushnell, James. 2023. “California’s Cap-and-Trade Market Enters its Teen-Age Years” <https://energyathaas.wordpress.com/2023/11/27/californias-cap-and-trade-market-enters-its-teen-age-years/>

- Leveraging the unprecedented funding opportunity through the Inflation Reduction Act available for a number of climate technologies.

In short, California should race to update its C&T Program with an ambitious cap trajectory so that decarbonization project developers can “stack” the opportunity for selling or avoiding the use of allowances on top of the competitive support and generous subsidies currently offered by the Inflation Reduction Act.

3. The CCMC Recommends Another Public Workshop with Updated Modeling Results

The CCMC appreciates that CARB undertook economic analysis of potential amendments to the C&T Program. Further, the CCMC understands the inherent difficulty of estimating allowance prices over a long time horizon starting in 2025 and extending beyond 2040.

Nonetheless, our analysis below of the underlying assumptions and modeling approach undertaken by UC Davis reveal serious concerns that critically undermine the reliability of resulting allowance price projections. Each of these concerns should be directly addressed in a subsequent round of economic modeling presented at another CARB public workshop.

The CCMC views an updated round of modeling as an essential foundation for the ongoing rulemaking process where CARB will make many policy design decisions that could endure well over 15 years into the future. Ideally, the CCMC encourages CARB to consider taking an alternative approach to modeling altogether, which focuses on the structure of California’s marginal abatement cost curve through 2045 rather than relying on a vector autoregressive (VAR) approach. In any case, the modeling presented by UC Davis should be updated before being used to inform changes to the C&T Program.

a. The Underlying Assumptions

The UC Davis team makes several additional unclear or unrealistic assumptions. The CCMC therefore recommends clarifying or relaxing each of these assumptions in a subsequent round of economic modeling. Otherwise, it will remain difficult to determine the accuracy of allowance price projections.

i. Lack of Clarity Around Complementary Policies

We understand that the UC Davis team augments its VAR approach by assuming abatement occurs from policies complementary to the carbon price according to the 2022 Scoping Plan. At the outset, this is confusing because the model seems to account for abatement from certain policies in the 2022 Scoping Plan, such as those pertaining to zero emissions vehicles (ZEV), but does *not* account for others—such as targets related to carbon capture and sequestration (CCS), direct air capture (DAC) and hydrogen. It would therefore be helpful for the modeling team to clarify precisely which policies are included in their analysis and which are not. One approach to communicate these assumptions clearly would be to provide stakeholders with a “waterfall” chart that could show business-as-usual emissions (1) minus abatement from each complementary

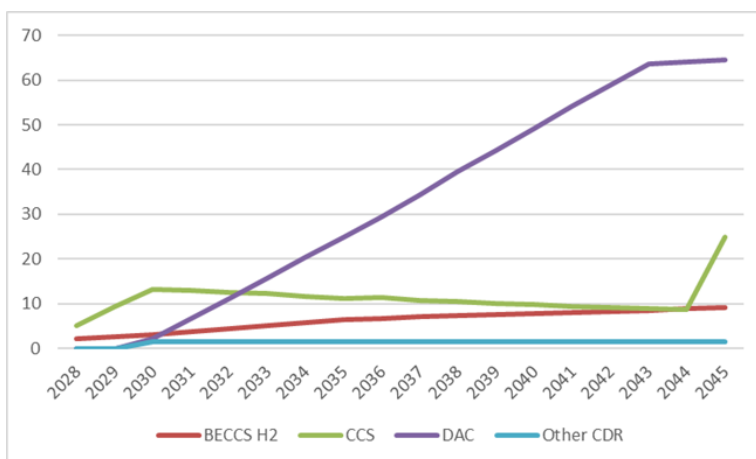
policy, (2) minus abatement from the carbon price, (3) plus the APCR supply, and (4) plus non-APCR supply.

We also understand that the UC Davis team treats abatement from complementary policies and targets in the Scoping Plan as insensitive to the carbon price. This seems counterintuitive because the carbon price helps with the achievement of many targets outlined in the Scoping Plan. Moreover, the carbon price is already in operation and already revealing allowance scarcity, whereas all of the targets in the Scoping Plan do not necessarily have the underpinning mandates or rules to guarantee their achievement. For these reasons, the CCMC questions whether counting abatement from complementary policies as price insensitive is a reasonable assumption and therefore recommends that this assumption be revisited.

ii. Failure to Account for Important Abatement Technologies

The 2022 Scoping Plan calls for substantial abatement from CCS, DAC, and hydrogen from bioenergy carbon capture and sequestration (BECCS H2). As shown in Figure 2, the E3 PATHWAYS Model used in the 2022 Scoping Plan calls for a total of 920 million tons of abatement between 2025 and 2045 from CCS (202 million tons), DAC (583 million tons), and BECCS H2 (112 million tons). In addition, the 2022 Scoping Plan calls for significant quantities of hydrogen supply from electrolysis and synthetic methane reformation with biogas in 2035 and 2045.

Figure 2
Deployment of Carbon Management Technologies in the 2022 Scoping Plan
Source: E3 PATHWAYS Model, 2022 Scoping Plan



The UC Davis team does not incorporate any of these abatement pathways. In and of itself, this calls into question the accuracy of the forecasted price projections. For context, the adjustments to 2025 through 2040 allowance budgets under consideration by CARB are 380 million tons (Alternative 1), 695 million tons (Alternative 3a and 3b), and 970 million tons (Alternative 2). The current modeling results show allowance prices at the price ceiling without abatement from carbon management technologies outlined in the Scoping Plan. However, if we assume that the C&T Program accounts for and/or incentivizes these abatement technologies, then the market could

reveal floating allowance prices between the price floor and the price ceiling, or perhaps even allowance prices resting on the price floor. This is because the quantity of abatement from carbon management (~920 million) in the Scoping Plan would probably be greater than the expected removal of allowances from the Alternatives under consideration between 380 million under a 40% Scenario to 970 million tons under a 55% Scenario. In short, the model omitted a set of carbon management technologies that could be the key determinant of allowance prices.

Whether the C&T Program will account for and/or incentivize the abatement technologies outlined in the Scoping Plan is an outstanding question that depends on the economic costs of deployment and additional regulatory hurdles. From a technical perspective, it is likely relatively straightforward to integrate CCS into the Program because CARB would simply need to net out verified and sequestered GHG emissions from the GHG emissions reported by covered facilities. In contrast, it is likely more technically complex to integrate DAC into the Program because these DACs are not “attached” to covered facilities. Without further opining on these technicalities, we proceed by focusing on CCS as an illustrative example because CARB Staff has discussed in recent workshops (e.g., June 14, 2023) that they are evaluating opportunities to align treatment of CCS within the C&T Program in light of the 2022 Scoping Plan and implementation of Senate Bill 905.

A Case Study on Carbon Capture and Storage

In the context of California’s C&T Program, a fundamental question is whether abatement from CCS would be induced at current or future allowance price levels. As illustrated below, a report by Lawrence Livermore National Lab and Clean Air Task Force indicates carbon can be captured in a range of applications from between 16 and 140 USD per ton.³ Similarly, reports from Boston Consulting Group identifies clusters of CCS in Southern California that may provide abatement at costs between 80 and 214 USD per ton.⁴ Finally, a recent report from the Clean Air Task Force illustrates how the deployment of CCS at operations in California and Texas cost between 60 and 132 USD per ton.⁵ Current and future allowance prices would substantially contribute to CCS deployment, especially when considering that cost levels will continue to drop as CCS developers gain experience and when accounting for unprecedented funding opportunities available through the Inflation Reduction Act.⁶ This finding is robust even *before* considering the substantial funding

³ LLNL and CATF. 2023. “Sharing the Benefits: How the Economics of Carbon Capture and Storage Can Serve Communities, the Economy and the Climate.” <https://gs.llnl.gov/sites/gf/files/2023-05/ca-ccs-economic-study-report.pdf>

⁴ Boston Consulting Group. 2020. “Think Small to Unlock Carbon Capture’s Big Potential.” <https://www.bcg.com/publications/2020/unlocking-carbon-captures-potential#:~:text=Carbon%20capture%20is%20potentially%20on,is%20mainstream%20and%20cost%20competitive>.

⁵ CATF. 2023. “Air Pollutant Reductions from Carbon Capture: An Analysis of the Air Quality and Public Health Benefits of Carbon Capture and Storage.” <https://www.catf.us/resource/air-pollutant-reductions-carbon-capture/#:~:text=The%20report's%20key%20findings%20are,point%20sources%20at%20these%20facilities>.

⁶ Boston Consulting Group. 2023. “Scaling Carbon Capture Won’t Break the Bank.” <https://www.bcg.com/publications/2023/scaling-carbon-capture-technology-wont-break-bank#:~:text=BCG's%20work%20with%20the%20Oil,how%20the%20math%20works%20out>.

for CCS deployment provided by the Inflation Reduction Act and highlighted in the 2022 Scoping Plan, including 9 billion USD in support for CCS and enhanced subsidies for CCS under 45Q.

Based on this analysis, it is possible that the 2022 Scoping Plan target of 202 million tons of abatement from CCS over the next 15 years is realized. If this occurs, then that level of abatement would be roughly sufficient to achieve more than half of a 40% Scenario, nearly one-third of a 48% Scenario, and one-fifth of a 55% Scenario. In any case, the contribution is substantial, underlying the importance of explicitly incorporating CCS into an updated round of economic modeling. The CCMC expects that analysis of DAC and hydrogen technologies would yield similar results, thereby further highlighting the importance of including these technologies in a subsequent round of economic modeling.

iii. Failure to Account for the Greenhouse Gas Reduction Fund

To date, nearly 10 billion USD of auction revenues have been reinvested through California Climate Investments, achieving an estimated 98 million metric tons of reductions in GHG emissions.⁷ Presumably, a significant portion of these GHG reductions occur in sectors covered by the C&T Program. Therefore, it would be helpful to further understand the assumptions, if any, that are made surrounding how auction revenue is reinvested into GHG reducing projects. This is especially pertinent to consider in the context of a 15-year horizon, where auction revenues may arguably increase substantially.

b. The Modeling Approach

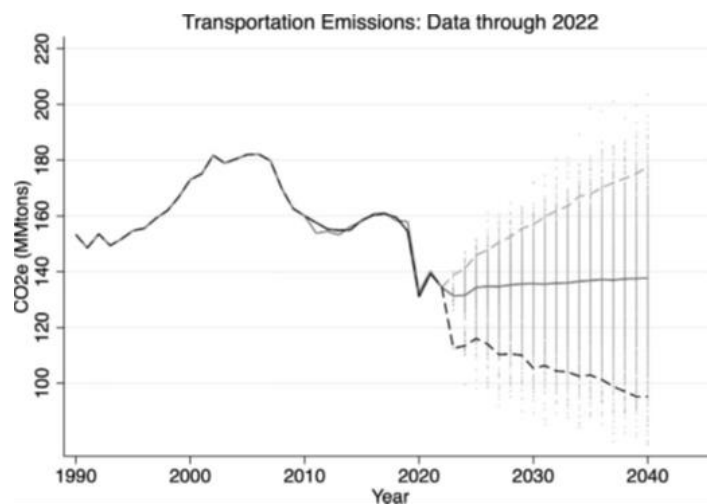
The UC Davis modeling team used a vector autoregression (VAR) model to forecast business-as-usual emissions through 2040 based on historical data from 1990-2022, then calculated net demand for abatement, and finally estimated price-responsive abatement caused by the carbon price in both 2030 and 2040. The team modeled one business as usual (BAU) scenario, which assumed no changes to the allowance budgets, and four “alternative” scenarios, which assumed various changes to the allowance budgets consistent with options outlined by CARB to date.

The advantage of VAR is that it is a flexible “theory-free” method of estimating relationships between GHG emissions and variables such as gross economic output and fossil fuel prices. The drawback of VAR is that it ignores inherent structural features of the underlying economic system, including dramatic policy and economic changes that occur over time. The CCMC questions whether VAR is the appropriate modeling approach in the context of California’s C&T Program. We argue that past statistical relationships do not inherently provide a sound technical basis for forecasting business-as-usual emissions. This is because most covered sectors in California’s C&T Program are undergoing fundamental changes driven by climate policies and economic transitions, thereby rendering observations of past relationships potentially irrelevant to predicting future emission levels.

⁷California Climate Investments. 2023. Annual Report dashboard.
<https://www.caclimateinvestments.ca.gov/annual-report>

We illustrate the drawback of using a VAR approach by focusing on the transportation sector, which represents 38 percent of California’s GHG emissions. As illustrated below in Figure 3, the model forecasts an *increase* in business-as-usual emissions in the transportation sector, resulting in nearly 140 MMT of GHG emissions in 2040. However, this directly contrasts with the 2022 Scoping Plan’s estimate for business-as-usual emissions from the transportation sector that substantially *decrease* over time, resulting in 93 MMT of GHG emissions in 2040. Overestimating forecasted emissions from the transportation sector, as the model seems to have done, would likely result in inflated price projections for allowance prices, all else equal.

Figure 3
 Business-As-Usual Estimate for Transportation Sector
 Source: UC Davis Presentation, November 16 CARB Workshop



The approach taken by the UC Davis team makes an overly restrictive assumption that GHG reductions occur *only* through “reduced fuel use” and “fuel switching”. In other words, the carbon price *only* leads to GHG reductions through lowered use of gasoline, electricity, or natural gas and/or switching that occurs across these fuels. This captures only a narrow subset of the pathways through which a carbon price causes GHG reductions. For example, the modeling approach ignores entire abatement pathways including changes to upstream energy supply such as CCS and DAC. Moreover, the modeling approach ignores fuel switching beyond the three fuels explicitly considered, such that a range of alternative clean fuels are effectively ignored. These omissions are at odds with CARB’s 2022 Scoping Plan, which relies heavily on changes to upstream energy supply and rapid expansion of new fuel types, including but not limited to hydrogen. Therefore, the CCMC expects these omissions resulted in substantial overestimations in the UC Davis allowance price projections, all else equal.

c. Request for Updated or Alternative Modeling

The CCMC recommends changing or at least augmenting the existing modeling approach. We expect these changes and augmentations would yield significantly lower allowance price projections.

Ideally, a comprehensive change to the modeling approach would include:

- Explicit incorporation of a marginal abatement cost curve that includes all known abatement pathways. A revised modeling approach along these lines has been implemented in a wide range of other studies and is entirely feasible (e.g., See Evolved Energy Research. 2021. Marginal Abatement Cost Curves for U.S. Net-Zero Energy Systems. Prepared for Environmental Defense Fund). This approach could either entirely replace or act additively to the VAR methodology employed by UC Davis.
- A broader treatment of “price sensitive” abatement that responds to the allowance price. For example, during the workshop, Dr. Bushnell said that if he were to incorporate CCS deployment into his model, then it would show up as “price insensitive” abatement. Taking this approach would substantially undercount the abatement caused by the C&T Program. In short, the C&T Program facilitates the success of many complementary policies and climate targets, and the modeling should reflect this reality.
- Accounting for uncertainty regarding whether policies/targets outlined in the 2022 Scoping Plan are likely to be met or exceeded, rather than simply assuming that they will be fully implemented. This is important because the Scoping Plan is a planning document rather than a series of mandates and rules, meaning there is substantial uncertainty regarding whether it is implemented exactly as envisioned.

Practically, marginal and targeted changes to the modeling should include:

- Projections through 2045 rather than 2040 for consistency with California’s climate goals under Assembly Bill 1279.
- Representation of a wide array of fuel switching options (beyond electricity, gasoline, and natural gas) to more accurately reflect technologies likely to be incentivized by the carbon price.
- Incorporation of abatement technologies that play an important role in the 2022 Scoping Plan (CCS, DAC, hydrogen) and abatement from auctioned allowances to more accurately reflect California’s climate policy mix.

4. The CCMC Recommends Maintaining Existing Banking Rules

At the November 16 Workshop, CARB asked whether changes to market rules could enhance liquidity and protect against price volatility, and outlined potential changes to consider, including:

- Modified banking rules
- Minimum trade activity requirements
- Duration limits on allowance holdings

The CCMC does not believe CARB needs to modify banking rules, impose minimum trade activity requirements, or impose duration limits on allowance holdings. We explain why below while addressing the following observations from the November 16 Workshop:

- There has been a steady increase of market participants over time, illustrative of current market conditions.

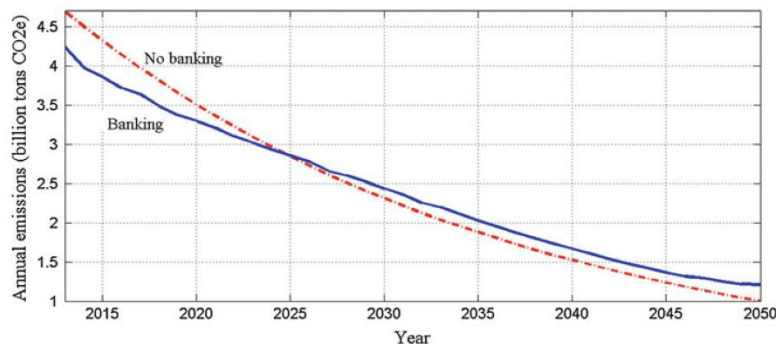
- Long-term allowance holdings or investments may reduce market liquidity considering the potential reductions in allowances.
- There is no current duration limit on holding allowances or a time limit to using allowances.
 - a. CARB’s Current Banking Rules Reflect Sound Program Design and Incentivize Early Emission Reductions

The CCMC fully concurs with CARB’s description of the benefits of banking, which we reiterate here. As noted by CARB at the November 16 Workshop, CARB’s current banking rules help to (1) reduce compliance costs and mitigate concerns about price volatility, (2) create compliance flexibility, (3) incentivize early emission reductions, and (4) encourage a long-term commitment from market participants. To quote Dr. Dallas Burtraw, Co-Chair of the IEMAC, “every successful program has enabled emissions banking; and indeed the exception proves the rule.” (Legal Planet, 2017).⁸

We would like to especially emphasize point #3 above, that allowance banking incentivizes early reductions in GHG emissions. Leard (2013) argues that allowance banking improves economic welfare by leading to lower emissions in the short run. Compared to a C&T program without banking, cumulative reductions over time remain unchanged, but more reductions occur earlier on, leading to an “environmental dividend”.⁹ Figure 4 below illustrates this result in the context of a simulation for a national C&T program in the United States.

The CCMC would further note that a focus on cumulative rather than annual emissions is appropriate. This view is consistent with the 2021 Independent Emissions Market Advisory Committee (IEMAC) report which states: “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.” This is also reflective of best practice from a climate science perspective, which argues for setting cumulative rather than annual targets since cumulative emissions map more directly into global temperature changes.¹⁰

Figure 4
Emissions With and Without Allowance Banking Under a National C&T Program
Source: Leard (2013)



⁸ Burtraw, Dallas. 2017. “Three Revisions Not to Overlook in California’s New Cap-and-Trade Proposal, SB 775.” Legal Planet. <https://legal-planet.org/2017/05/10/guest-blogger-dallas-burtraw-three-revisions-not-to-overlook-in-californias-new-cap-and-trade-proposal-sb-775/>

⁹ Leard, Benjamin. 2013. “The Welfare Effects of Allowance Banking in Emissions Trading Programs.” *Environmental and Resource Economics* 55: 175-197.

¹⁰ Gianfranco, Chicco and Paule M. Stephenson. 2012. “Effectiveness of Setting Cumulative Carbon Dioxide Emissions Reduction Targets.” *Energy* 42(1): 19-31.

b. Banking Restrictions Have Introduced Significant Price Volatility and Led to Underperformance in Other Programs

Beyond the theory of allowance banking, the CCMC highlights the following real-world examples that demonstrate that carbon markets without banking or with restrictions on banking face volatility and underperformance.

Example 1. In 1994, the South Coast Air Quality Management District launched the Regional Clean Air Incentives Market (RECLAIM), the first large-scale urban regional cap-and-trade program for NO_x. The program did not allow covered sources to bank allowances for future use; rather, allowances had to be used in the year that they were allocated. That market faced price spikes (from \$1 to \$60/allowance in the span of one year) as a result of a tightening cap and demand that outpaced supply. As observed by Burtraw et al. (2009) “Had banking been allowed, sources with low-cost abatement options would have had an incentive to adopt them early and retain the allowances for future periods. Banking gives sources a greater incentive to think about their long-term position in the market.”¹¹

Example 2. EU ETS prices oscillated in the first pilot period (2005-2007) in part due to certain restrictions on banking. Specifically, there was a drop in allowance prices in response to the inability to bank allowances for use in the second period (2008-2012). Ellerman et. al (2008) characterize this inability to bank between periods as “one of the major design flaws of the trial period,” further observing that banking helps dampen price volatility.¹²

Example 3. The South Korea emissions trading system has experienced substantial volatility from near \$0 to over \$30 primarily due to low liquidity caused by a combination of restrictions on allowance banking and limitations on voluntary participation.

c. Increased Market Participation and Long-Term Allowance Holdings Contribute to Rather Than Hamper Market Liquidity.

The “steady increase of market participants over time” observed by CARB has in our view been a key contributor to market liquidity and efficiency as evidenced by available data. For example, to date, auctions seem to be more competitive when voluntarily associated entities participate, as evidenced by the Herfindahl-Hirschman Index (HHI), which is a “common measure of market concentration used to express competitiveness.”¹³ Consistent with recent HHI data, market trading also appears to be higher, rather than lower, as more voluntarily associated entities joined the market. For example, from 2014 to 2015, average market transfers were in the range of 150 million allowances in contrast to 380 million allowances in 2022. In addition, because compliance entities are the only natural buyers of allowances, their future demand will be met so long as there

¹¹ Burtraw, Dallas and Sara Jo Szambelan. 2009. “U.S. Emissions Trading Markets for SO₂ and NO_x”, Resources for the Future. <https://media.rff.org/documents/RFF-DP-09-40.pdf>

¹² Ellerman, Denny and Paul Joskow. 2008. “The European Union’s Emissions Trading System in Perspective.” Massachusetts Institute of Technology. <https://economics.mit.edu/sites/default/files/2022-09/EU%20Emissions%20Trading%20System%20in%20Perspective.pdf>

¹³ California Air Resources Board. 2023. Cap-and-Trade Program Data Dashboard. <https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-data/cap-and-trade-program-data-dashboard>

is sufficient supply. In other words, concerns about liquidity would actually be *more* present in a market with fewer market participants.

We are not familiar with any other benefits associated with imposing minimum trade activity requirements or imposing “duration limit on holding allowances or a time limit to using allowances.” To the contrary, these restrictions would likely introduce distortions that could counteract the benefits of banking identified by CARB above. By way of example, a holding duration of 10 years would lead to a devaluation of older allowance vintages, introducing differentiation between what are supposed to be fungible allowances. The result would be a reduction in certainty and credibility that would likely stymie rather than promote further liquidity.

d. A More Stringent Cap Calls for Banking Flexibility

Changing the stringency of the Program does not call for changes to the banking rules or restrictions on banking. To the contrary, these banking rules are ever more important in the context of a tighter cap to ensure the benefits mentioned above continue to be felt by the market. The potential changes identified by CARB limit rather than enhance liquidity and price volatility and should not be implemented.

5. Conclusion

We thank CARB for the opportunity to comment on this public workshop. We look forward to engaging with Staff on the concepts contained within this comment letter and to future engagement through additional public workshops.

Sincerely,



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