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OVERSUPPLY GROWS IN THE WESTERN CLIMATE INITIATIVE CARBON MARKET

An adjustment for current oversupply is needed to ensure the program will achieve its 2030 target

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By Chris Busch

Contents

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SUPPORTING DOCUMENTATION

A spreadsheet containing the calculations and details about the analysis is downloadable at:
http://energyinnovation.org/wp-content/uploads/2017/12/WCI_market_balance_evaluation.xlsx

PREFACE

This report was updated in February 2018, principally involving an updated source with respect to the market balance for Ontario.

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EXECUTIVE SUMMARY

2017 has been a landmark year for California's cap-and-trade program. In July, Assembly Bill 398 (AB 398) was passed and signed into law, solidifying legal authority for the state's cap-and-trade program through 2030. In September, California and Quebec, which have operated a linked cap-and-trade program since 2014, welcomed new partner Ontario, to the Western Climate Initiative (WCI)'s carbon market. In another milestone, cap-and-trade has emerged as the single largest policy in California's 2030 climate strategy. It is responsible for 38 percent or more of emission reductions in the California Air Resources Board's analysis of its 2017 Scoping Plan,[1] the strategy for achieving the 2030 target requiring emissions to be at least 40 percent below 1990 emissions.[2]

The increasing importance of cap-and-trade in California's policy portfolio increases the stakes for program design. The cap-and-trade program must be judged a success in the overall context of policies helping the state achieve its 2020 emission reduction target, and is reducing emission thanks to its price floor. The WCI cap-and-trade program is the best designed in the world. However, covered emissions have been consistently lower than the annual cap. Thus the cap-and-trade program is "oversupplied."

Oversupply has emerged due to a mix of economic, technological, and policy factors, which have driven emissions below cap levels. The electricity sector's strong decarbonization performance, spurred on by sector policies and renewable energy innovations, deserves much of the credit. Emissions also dropped sharply in 2009 due to the recession, after the initial program design was established but before the cap-and-trade program had begun operating.

This analysis estimates cumulative oversupply through 2020 for the combined WCI market at 270 million metric tons (MMT) with an uncertainty interval of 200-340 MMT. The emergence of oversupply does not reflect an initial design flaw, but it should be addressed sooner than later. Allowances never expire, so excess allowances can be purchased and saved for later use, a practice known as banking. Unaddressed, oversupply and expected banking is large enough to allow for significantly more emissions than intended under the 2017 Scoping Plan, cutting into planned cumulative emissions and possibly leaving 2030 emissions above the SB 32 target. The same implications hold for the WCI. The accumulation of an expected bank of allowances would substantially cut into reductions that would otherwise be expected to accrue under the cap.

[1] This report uses the abbreviated term, "2017 Scoping Plan," for the document with the full title:
2017 Climate Change Scoping Plan: The Strategy for Achieving California's 2030 Greenhouse Gas Target.
https://www.arb.ca.gov/cc/scopingplan/revised2017spu.pdf
We work from the most current version available at the time of release, dated October 27, 2017.

[2] SB 32 bill text at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

Methodology

The analysis calculates annual balances in the market as the supply of compliance instruments (allowances and offsets) minus compliance demand, with the cumulative balance through any given year as the sum of annual balances. Because Ontario has not released necessary facility-level emission data, the analysis integrates a separate, independent estimate of the market balance for that province.[3]

Emissions are the driver of demand. In the absence of emissions, there is no compliance obligation, allowances would have no value, and there would be no demand. Hence emissions are a reasonable proxy for demand, even though a complex web of causality underlies it. Historical data exist through 2016. In the mid-scenario forecast, the historical emission trend is projected forward at a 1.9 percent reduction per annum over 2017-2020. The high demand scenario models emissions staying constant at the 2016 level. The low demand scenario models emissions falling at four percent annually.

The supply of allowances is known and tracked through compliance instrument reports. Offsets are a secondary compliance option, which can represent up to eight percent of compliance through 2020. Offsets are emission reduction credits from sectors not covered under the cap or from other geographic areas. Historical data on offset use exist for 2013-2014, the first compliance period, when offset use was just over four percent. Forecasting is required for other years. The analysis forecasts offset use as covering five percent of emissions and conducts sensitivity analysis on the offsets variable.

The supply of allowances takes into account a new rule regarding the treatment of allowances that went unsold at auction due to the price floor. Our analysis estimates that about 40 of 118 MMT of unsold allowances will be diverted to the Allowance Price Containment Reserve (APCR) as a result. APCR allowances are excluded from the estimation of oversupply through 2020, though they may become a factor after 2020.

Results

Figure ES-1 shows the year-by-year trends and the division between historical data and forecasts. Emission levels, representing compliance demand, are colored green, with the solid line indicating empirical data and the dotted line representing the mid-scenario forecast, which is the only one shown for simplicity. The blue line shows supply. The difference between the two, the annual balance in the market, is highlighted with a gold bar.

[3] Sawyer, Dave, Jotham Peters, Seton Stiebert. "Overview of Macroeconomic and Household Impacts of Ontario's Cap and Trade Program," EnviroEconomics and NaviusResearch. May 2016.

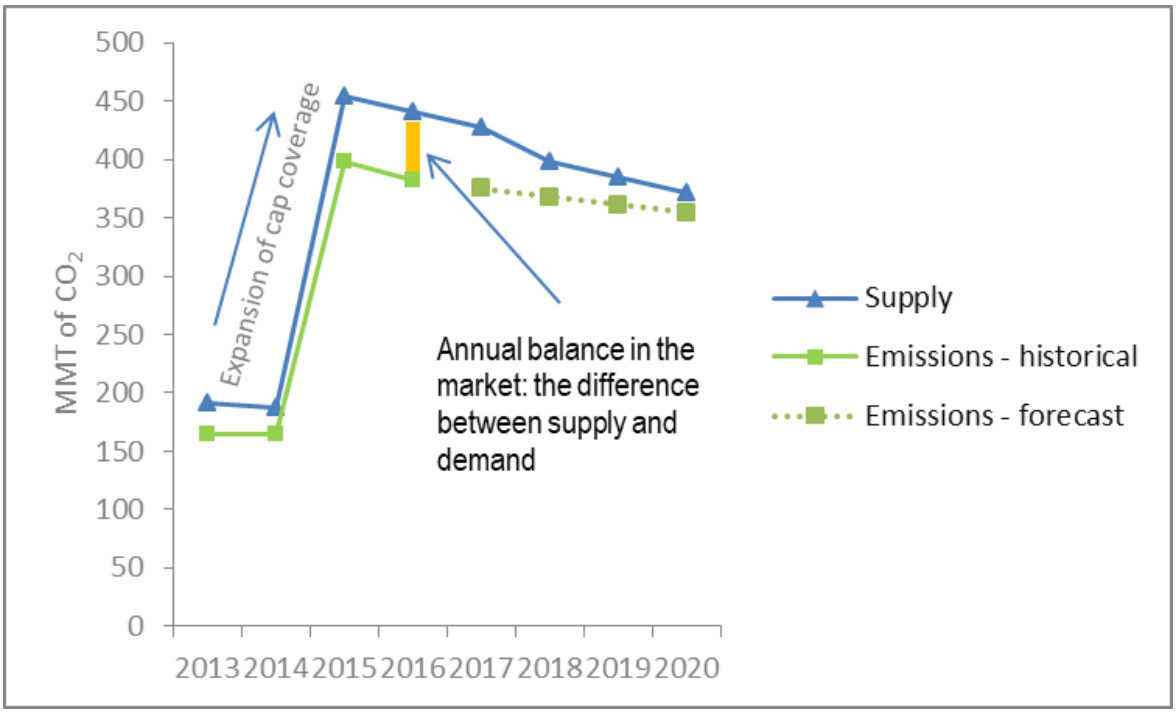

Figure ES-1. Market balance for California and Quebec suggest oversupply continues until 2020.

The next graph tracks the annual balance how it affects the cumulative balance through 2020.

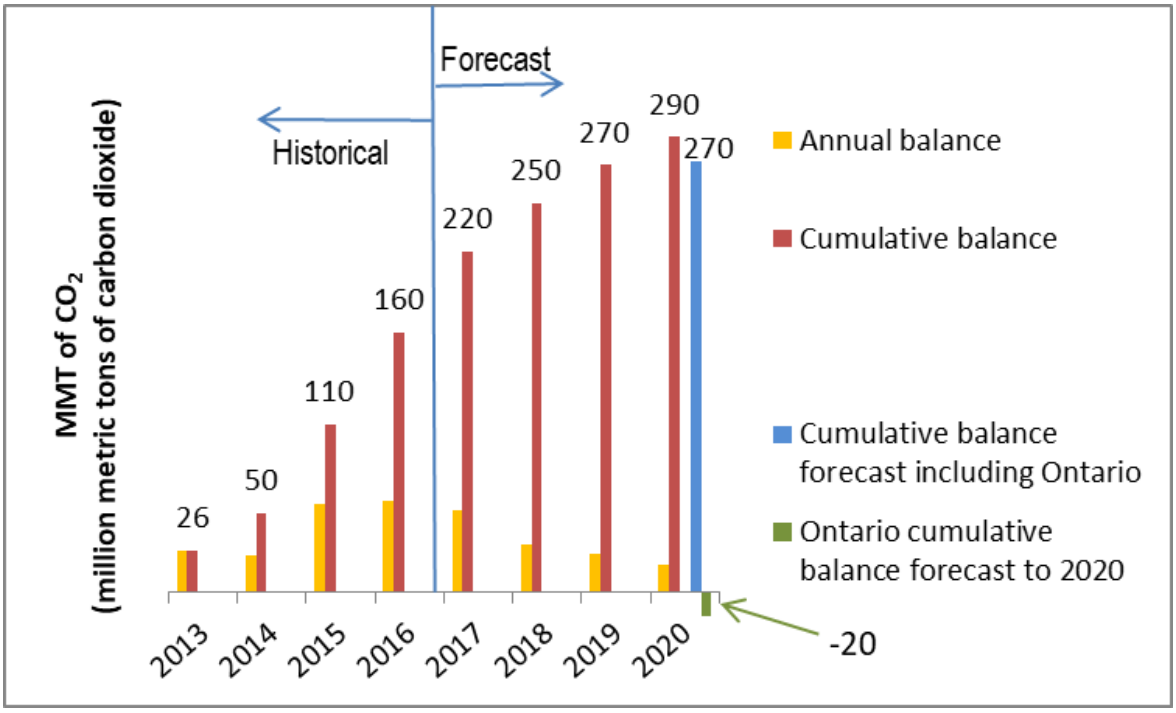

Figure ES-2. Annual oversupply appears to have peaked in 2016 but cumulative oversupply still climbing. Integrating Ontario does not change the basic outlines.

Figure ES-2 shows the annual balance using the same gold bar as Figure ES-1. Recently released data show that oversupply reached a new maximum in 2016, which supports the conclusion that WCI oversupply has grown. This analysis suggests the extent of oversupply will decline in coming years, though emissions are not likely to fall below cap levels until 2020 or later. The cumulative market balance for California-Quebec is shown in red, and climbs to 290 MMT in 2020. An estimate of the cumulative balance through 2020 in the Ontario market, negative 20 MMT, is shown in green.[4] The blue bar provides an integrated estimate of 270 MMT in oversupply for the WCI, which ranges from 200-340 MMT in the high and low emission sensitivities.

Implications

Because unused allowances, the tradable emissions permits at the core of the program, can be saved and used later, this oversupply will very likely be banked. Banked allowances enable higher emissions than would otherwise occur by effectively raising future cap levels above those established by regulation. The California Air Resources Board's (CARB) analysis expects reductions from cap-and-trade over 2021-2030 to be in the range of 236-305 MMT. The problem is that CARB's analysis does not account for the likelihood of banked allowances held over from before 2021. Given the magnitude of oversupply, if ignored, the impact of banked allowances would certainly result in significantly fewer cumulative emission reductions from 2021-2030, and creates the potential for California to end up above the 2030 statewide emission limit. These implications hold even if prices stay near the price floor.

In a fully linked market, allowances are fungible. The forecasted bank of allowances could be used in any WCI jurisdiction and it makes the most sense to consider the implication within that context. The estimate effect is measured against the intended decline in WCI cap levels over time. The forecasted bank accumulated through 2020 at the mid-scenario level of oversupply would effectively raise WCI caps 35 percent over 2021-2030 and could effectively negate WCI cap reductions until 2025 or 2026.

Recommendations

To account for oversupply, California and the WCI should adjust caps for 2021-2030 downward in an amount equal to the sum of 2020 and earlier vintage allowances that remain privately held after emitters have finished submitting allowances for compliance through the end of 2020.

This straightforward adjustment to program design can resolve the issue. Because it involves adjusting future caps downward to account for the amount of allowances banked, this approach does not harm private holdings of allowances and it does not involve a change in banking rules. It does not encourage greater volatility and it only increases the incentive for early action. In

[4] Sawyer, Dave, Jotham Peters, and Seton Stiebert. "Overview of Macroeconomic and Household Impacts of Ontario's Cap and Trade Program," EnviroEconomics and NaviusResearch. May 2016.

2014, this modification to program design was successfully used by the Regional Greenhouse Gas Initiative, a cap-and-trade program in Eastern U.S. states, to address oversupply.

CARB and the WCI should also adopt a specific schedule for program review. These regular reviews – we suggest at the end of each compliance period – should evaluate cap-and-trade program performance. The October draft of the 2017 Scoping Plan increases the emphasis on periodic reviews but is short on specifics, beyond noting the five-year Scoping Plan cycle.

Some might protest that reducing allowance supply would increase carbon prices. While a higher carbon price indicates higher compliance costs for emitters, it does not necessarily equate to higher social costs. Higher carbon prices offer two important benefits almost invariably left out of economic analyses: (1) greater public health benefits, including reduced health care costs, better student performance, and higher worker productivity, and (2) greater competitiveness for domestic clean technology companies, which are then more likely to capture a larger share of the fast growing international market for clean tech.

In addition, California's initial experience points to the positive coexistence of declining carbon emissions and robust economic growth. And despite the cost bias inherent in economic modeling, some studies indicate meeting the 2030 target will have overall economic benefits.[5] Nonetheless, since the 2030 target is much more aggressive than the 2020 target, it is appropriate for policy design to acknowledge uncertainty. AB 398 is helpful in this regard, requiring the establishment of a hard price ceiling, guaranteeing carbon prices will rise no higher than that ceiling. This should provide policymakers the confidence to correct for early oversupply.

Conclusion

While early oversupply itself does not represent a mistake, it would be a mistake not to adjust for it. For California, cap-and-trade is playing an increasingly important role in the state's climate strategy to achieve the emission reductions in statute. The program is well suited to providing the firm cap needed to successfully hit the target, but if early oversupply rolls forward unaddressed, emissions will be significantly higher than intended caps. There is no guarantee that the price floor will deliver the intended emissions reductions. California and the WCI should course correct, lowering future caps to account for early oversupply.

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[5] For an example, see David Roland-Holst. 2015. *California Climate Policy to 2050: Pathways for Sustained Prosperity.* Next 10 report. Table ES-3 shows carbon pricing plus a strong vehicle electrification push to hit the 2030 target increases both Gross State Product and employment by two percent above the business-as-usual scenario.

INTRODUCTION

2017 has been a landmark year for California's cap-and-trade program, including new statutory authority and partners. Assembly Bill 398 (AB 398) was passed and signed into law in July, solidifying the legal and policy framework for the state's cap-and-trade program through 2030.

In another major step, California and the Canadian Province of Quebec, which have operated a linked cap-and-trade program since 2014, welcomed a new partner, Ontario. On September 22nd, 2017, the three jurisdictions signed a new linkage agreement establishing a common carbon market among the three jurisdictions.

In a third milestone, cap-and-trade has emerged as the single largest policy in California's 2030 strategy. It is responsible for 38 percent or more of emission reductions in the California Air Resources Board's analysis of its 2017 Scoping Plan,[6] the strategy for achieving the Senate Bill 32 target for 2030 requiring emissions to be at least 40 percent below 1990 emissions.[7]

The new importance of cap-and-trade in California's policy portfolio increases the stakes for program design. While the cap-and-trade program must be judged a success in the context of the package of policies helping the state achieve its 2020 emission reduction target, and the return to strong auction sales is a positive result, the issue of oversupply threatens to depress its future effectiveness. Oversupply is defined as occurring when the supply of compliance instruments exceeds demand for them.

The WCI cap-and-trade program is the best designed in the world, not least because its price floor is the highest. Oversupply has emerged due to a mix of economic, technological, and policy factors, which have driven emissions below cap levels. The electricity sector's strong decarbonization performance, spurred on by sector policies and renewable energy innovations, deserves much of the credit. Emissions also dropped sharply in 2009 due to the recession, after initial program design was established and before the cap-and-trade program had begun operating. While cap-and-trade is reducing emissions thanks to the price floor, most emissions reductions are due to other factors.

Left unchecked, oversupply threatens to significantly erode the reductions from cap-and-trade predicted in the analysis underlying California's 2017 Scoping Plan. Fortunately, a straightforward adjustment to program design, tested and proven effective by the Regional Greenhouse Gas Initiative (RGGI) cap-and-trade program in nine Eastern U.S. states, can resolve the issue. Essentially, this involves adjusting future caps downward to account for the amount of

[6] This report uses the abbreviated term, "2017 Scoping Plan," for the document with the full title: 2017 Climate Change Scoping Plan: The Strategy for Achieving California's 2030 Greenhouse Gas Target. https://www.arb.ca.gov/cc/scopingplan/revised2017spu.pdf

We work from the most current version available at the time of release, dated October 27, 2017.

[7] SB 32 bill text at https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

allowances banked. This recommendation does not negatively affect private holdings of allowances, while eliminating he risk that banked allowances could significantly knock the state off the course as it drives toward the aggressive SB 32 target for 2030, which requires emissions to be 40 percent below 1990 emissions.[8]

AB 398 CONTEXT AND NEXT STEPS

For a period of about 18 months, until May of 2017, the California-Quebec program's auctions were buffeted by erratic demand. For example, the February 2017 auction sold less than 20 percent of allowances made available, meaning there was not enough demand at the auction floor price. Low demand had occurred because of questions around legal authority as well as oversupply. On the topic of oversupply, AB 398 directs regulators to: "Evaluate and address concerns related to over-allocation in the state board's determination of the number of available allowances for years 2021 to 2030, inclusive, as appropriate."[9]

The adoption of AB 398 by a two-thirds supermajority resolved legal uncertainties surrounding the program. Even earlier, an April decision in California's Supreme Court declared that auctioning allowances was legal, and not the illegal tax petitioners had claimed. Together, these developments have firmed up confidence in the program's longevity.

As a result, the August auction returned a record settlement price of $14.75 per ton, which was surpassed by a new record auction price in November of $15.06 per ton. The November auction began the reintroduction of previously unsold allowances to supply. Regulation calls for unsold allowances to be returned to the market through auctions over time after the settlement price exceeds the floor at two consecutive auctions.

AB 398 gives CARB discretion over many program aspects, while requiring some specific changes, for example establishment of a true price ceiling. The cap-and-trade program currently relies on a supply of allowances (the Allowance Price Containment Reserve, or APCR) that would be sold if prices reached pre-determined thresholds. In theory, the APCR could be depleted, allowing prices to rise higher than desired. However, AB 398 directs CARB to make available an unlimited number of permits at the ceiling price if demand at auction reaches that level, ensuring the price ceiling will never be exceeded. Revenue from sales of allowances created at the price ceiling will go to procure additional emission reductions, in an effort to neutralize the additional emissions enabled by the creation of allowances above the original intended cap level. At least two-thirds of allowances in the APCR will be put into analogous new reserve accounts to be made available at prices, to be determined by CARB, below the price ceiling.

[8] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

[9] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398

METHODOLOGY

Oversupply is defined as a situation in which demand, represented by emission levels, is below the supply of compliance instruments. The methodology can be summarized as an equation:

Oversupply = Supply of compliance instruments – Demand

Emissions stand as a proxy for demand. While a variety of underlying factors ultimately determine demand, emissions are the main causal driver. Emissions create the need to acquire allowances. Put differently, without emissions, there would be no demand for allowances, and allowances would have no value.

The supply of compliance instruments includes both allowances and offsets. Offsets are emission reduction credits from sectors not covered under the cap or from other geographic areas. While most demand must be covered with allowances, offsets are an alternative compliance option. For the purpose of evaluating market status, offset use reduces the demand for allowances, so it makes sense to include offsets as an element of supply.

Oversupply can occur in a single year and it is also building over time. As well, it is necessary that the opposite of oversupply, shortage is also expected to emerge. So, a more neutral terminology, market balance, is appropriate. Define the annual balance as the sum of compliance instruments in the market (allowances distributed and offsets used) less compliance demand. The cumulative balance through a given year adds the annual balances up to and including that year.

The mathematical definition can be extended to differentiate annual and cumulative balance as follows:

Annual balance = Supply of compliance instruments in a given year – Demand in that year

Cumulative balance = sum of annual balances

In addition to the more detailed discussion below, the appendix walks through each component of the analysis in detail, providing an annotated discussion of underlying calculations. The spreadsheet itself is publicly available and provides sources for underlying data.

The analysis directly calculates the market balance in California and Quebec, but was unable to integrate Ontario into the framework because it has not released the necessary facility level emission data we use to evaluate the demand side of the market. Such data is currently only provided for: “Facilities in the electricity generation sector, manufacturing sectors and large institutional energy users are captured by the reporting regulation.”[10] Ontario’s cap-and-trade regulation also covers fuel distributors and natural gas distributors, as do the programs in California and Quebec.

[10] Greenhouse Gas Reporting by Facility, https://www.ontario.ca/data/greenhouse-gas-emissions-reporting-facility

Other analysts have estimated that Ontario's cap-and-trade program will be 18.7 million metric tons (MMT) short (undersupplied) through 2020. [11] These results are integrated into the analysis. The integration of Ontario does not fundamentally change the results and narrative that emerges from the analysis with California and Quebec data.

Quick methods summary

Demand

> Main scenario forecasts using past trend, i.e. emission reductions at, 1.9 percent per annum

> Uncertainty range: 0 – 4 percent annual reductions

High demand = emissions plateau; emissions remain steady at 2016 level through 2020

About 2 percent per annum higher than the historical rate

Low demand = emission under the cap decline at 4 percent annually

About 2 percent per annum lower than the historical rate

Supply

> Allowances as listed on compliance instrument report

> APCR allowances are not expected to be released before 2020, and hence are excluded from oversupply through 2020 estimation. APRC allowances could be a factor after 2020

> Offset use assumed at 5 percent 2015-2020 and at empirical level (~4 percent) 2013-2014

> Takes into account allowances sent to APCR due to new treatment of allowances unsold after 24 months

Ontario

> Ontario is integrated indirectly. Insufficient data exist for direct inclusion.

[11] Sawyer, Dave, Jotham Peters, and Seton Stiebert. "Overview of Macroeconomic and Household Impacts of Ontario's Cap and Trade Program," EnviroEconomics and NaviusResearch. May 2016.

Analysis from the advisory firm Clear Blue Markets suggests that Ontario will do less to help absorb oversupply. Their evaluation of the Ontario market indicates it will be less than one MMT short (0.7) cumulatively through 2020: "Without taking offsets into account, ClearBlue now expects the Ontario market to be short by 21.9 mt for the first compliance period (2017-2020), down from their previous forecast of 23.5 mt. However, as offsets begin to be issued in Ontario and as entities start using imported credits following the markets' linkage, this overall shortage is expected to be reduced to just 0.7 mt amid 21.2 million surrendered offsets by Ontario emitters."

Sophie Yeo. 29 November 2017. "Declining Emissions Forecast Points to an Even Longer Market in 2017," *Carbon Pulse*.

DEMAND

Emissions drive demand as allowances have no value without a compliance obligation. A range of future forecasts are used to capture uncertainty about future emission trends. 2016 emissions data was released in November 2017, but four years of future emissions must be forecasted to estimate oversupply through 2020.

We use a simple extrapolation of the past trends as the basis for future emission forecasts. Our main scenario uses the historical trend (1.9 percent annual reductions) to forecast future emissions. In 2014 and 2015, emissions dropped about one percent, then in 2016 emissions dropped four percent. This was driven by a decline of five percent in California, where electricity sector reductions led the way.[12]

Given substantial uncertainties about future emissions, the analysis tests a wide range of future emission scenarios, adding or subtracting roughly two percent to the trend assumed in the main scenario. So, the high demand scenario investigates the implications of flat emissions levels at the 2016 level over 2017-2020. The low demand scenario considers emission reductions of four percent per year.

SUPPLY

The supply of allowances is fixed and known according to regulation. It takes some work to interpret the compliance instrument reports, but these lists in precise detail the status of all allowances created.[13] These reports show all allowances that have already been retired; those held by private entities (emitters and speculative purchasers), and those still slated for distribution. For reasons explained below, allowances in the ACPR are excluded from this analysis.

Offsets are less straightforward. Any given emitter can cover up to eight percent of emissions with offsets through 2020. However, less than maximum allowable amount is being used. The amount used is known for the first compliance period, 2013-2014, when only about half of the maximum use occurred, a fraction over four percent.[14] The next compliance period ends this year (2015-2017), but emitters have until November 1, 2018 to complete their submissions. Hence, some forward-looking scenario analysis is required for the years 2016-2020.

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[12] Danny Cullenward, Mason Inman, and Michael Mastrandrea. 2017. *California's climate emissions are falling but cap-and-trade is not the cause.* http://www.nearzero.org/wp/2017/11/10/californias-climate-emissions-are-falling-but-cap-and-trade-is-not-the-cause/

[13] The latest compliance instrument report is also posted at: https://www.arb.ca.gov/cc/capandtrade/complianceinstrumentreport.xlsx

[14] In the first compliance period (2013-2014), 95.6 percent of California's covered emissions were covered through allowances and 4.4 percent from offsets, with a boost in offsets evident in the first filing of the second compliance period. An even smaller fraction of Quebec's emissions were covered through offsets. 2013-2014 compliance instrument report available at: https://www.arb.ca.gov/cc/capandtrade/2013-2014compliancereport.xlsx

The central assumption assumes five percent offset use on average going forward, and sensitivity analysis explores other levels. Ultimately, sensitivity analysis shows that different assumptions around future emission levels matter more than offset use. The five percent assumption is intended to reflect somewhat increasing use in practice, which would be expected as the market tightens, and this level comports with expectations of carbon traders. To reflect the uncertainty around offset use, we provide oversupply estimates for different levels of use at four, six, and eight percent.

While full second period compliance will not be completed until November 1, 2018 with public release of the date after that, we do have partial information. Emitters must submit compliance instruments to account for 30 percent of their annual emissions. The 2015 compliance report shows offset use of 7.9 percent, but traders closer to market participants and daily transactions expect that this will not be representative of overall offsets usage for the second compliance period (2015-2017). At the same time, reasons exist to expect increasing offsets usage along with higher prices, due to recent auction results, strong legal certainty through 2030, and the aggressive reduction targets called for under SB 32. Higher allowance prices increase the attractiveness of offsets. Finally, new products removing buyer risk have been introduced.[15]

ACCOUNTING FOR NEW TREATMENT OF UNSOLD ALLOWANCES

This section explains the approach to estimating how new treatment of allowances that have gone unsold at the price floor would be expected to affect allowance supply. CARB has adopted a rule that will send some unsold allowances to the ACPR. While the Canadian provinces may follow suit, we do not know so with certainty, and implement this only for the California allowances that went unsold.

The price floor held back 118 MMT in current vintage California state-owned allowances (or, "ARB allowances"), a term used to differentiate allowances distributed by the state through auctions from allowances consigned on behalf of utilities.[16] If allowances consigned on behalf of utilities are unsold, these are eligible for reintroduction immediately at the next auction. However, ARB allowances are only reintroduced at auction after two consecutive auctions have cleared (sold all available allowances) at a settlement price above the price floor (technically called the auction reserve price). [17] The same is true for allowances created under Quebec's

[15] Under California's system, buyers assume the risk of invalidation. But new products offer insurance that does away with the risk for a small price premium over other offsets. For more reading: http://www.ecosystemmarketplace.com/articles/invalidation-risk-still-shadows-california-offsets-market/

[16] For more information, see: CARB. "Guidance for Allowance Consignment to Auction." https://www.arb.ca.gov/cc/capandtrade/auction/consignment_guidance.pdf

[17] For more information, see: CARB. "Guidance on Treatment of Unsold Allowances Following an Undersubscribed Auction." https://www.arb.ca.gov/cc/capandtrade/guidance/guidance_unsold_allowances.pdf

regulation.[18] In both California and Quebec, previously unsold allowances recommence roll back into auctions at a rate of 25 percent of the originally intended auction amount for both California and Quebec.[19]

AB 398 enshrines in law changes to the treatment of unsold ARB allowances in California that had been developed in the most recent Cap and Trade amendment rulemaking, sending these to the APCR if they have gone unsold for more than 24 months.[20] This rule is expected to be implemented retroactively starting in January 2018, meaning that the clock for the amount of time an allowance has gone unsold will date back to the original date it was unsold.[21]

Our updated analysis integrates the expected impact of this new treatment of unsold allowances and includes an assumption that auction clearing prices will remain above the floor through at least 2020. The numerical results show that, if the forecast that fully subscribed auctions continue to be the norm, then approximately 42 MMT from regular auction supply would be diverted to the APCR. This should be thought of as a lower bound of the impact. If auction

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[18] Quebec's implementing regulation states: "Emission units of the vintage of the current or a previous year that remain unsold after an auction may be put up for sale as soon as the final sale price of the emission units has been above the minimum price for 2 auctions. Emission units of the vintage of a year subsequent to the year of the auction are put up for sale again when their vintage becomes the vintage of the current year. However, the quantity of emission units put up for sale again in accordance with the first paragraph cannot exceed 25% of the quantity of emission units initially planned for the auction." O.C. 1297-2011, s. 54; O.C. 1184-2012, s. 34; O.C. 902-2014, s. 35.

http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/Q-2,%20r.%2046.1

While this leaves some question as to whether the number will be 25 percent or less, CARB's asserts that the value will be 25 percent.

"The Québec cap-and-trade regulation uses the same 25 percent limit on the return of unsold Québec provincial-owned allowances. Under the Québec regulation, Québec would be able to re-designate 2,500,000 allowances (25 percent of the 10 million allowances indicated in Table 1) that remained unsold from prior auctions." See page 4 of CARB's "Guidance on Treatment of Unsold Allowances Following an Undersubscribed Auction." https://www.arb.ca.gov/cc/capandtrade/guidance/guidance_unsold_allowances.pdf

[19] In the case of California, the 25 percent is calculated in relation to the sum of both ARB and consigned allowances.

[20] "Requires that current vintage allowances designated by the state board for auction that remain unsold in the auction holding account for more than 24 months to be transferred to the allowance price containment reserve." https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398

[21] Based on personal communication with Jason Gray, Chief of the Climate Change Program Evaluation Branch at CARB. This aligns with the timing CARB had previously stated, as at p. 17 of the Initial statement of Reason https://www.arb.ca.gov/regact/2016/capandtrade16/isor.pdf): "Staff is proposing amendments to the Regulation to include a method for transferring State-owned (not consigned) allowances that remain unsold at auction for a significant period of time to the Reserve with the amendments taking effect by January 1, 2018. The proposed method would specify that allowances that remain unsold for more than 24 months would be transferred to the Reserve. The proposed amendment can also be viewed as requiring the completion of eight auctions before the transfer could be effected. This means that beginning in 2018, any previously unsold allowances owned by the State that have been in ARB's Auction Holding Account for 24 months would be transferred to the APCR."

demand falters unexpectedly before then, it is possible that a greater number of allowances would end up being sent to the reserve.

Figure 1 shows the buildup in unsold allowances to the current total of 118 MMT starting with the Q1 2016 auction and the forecasted future rate of re-introduction to the market at auction and diversion to the APCR.

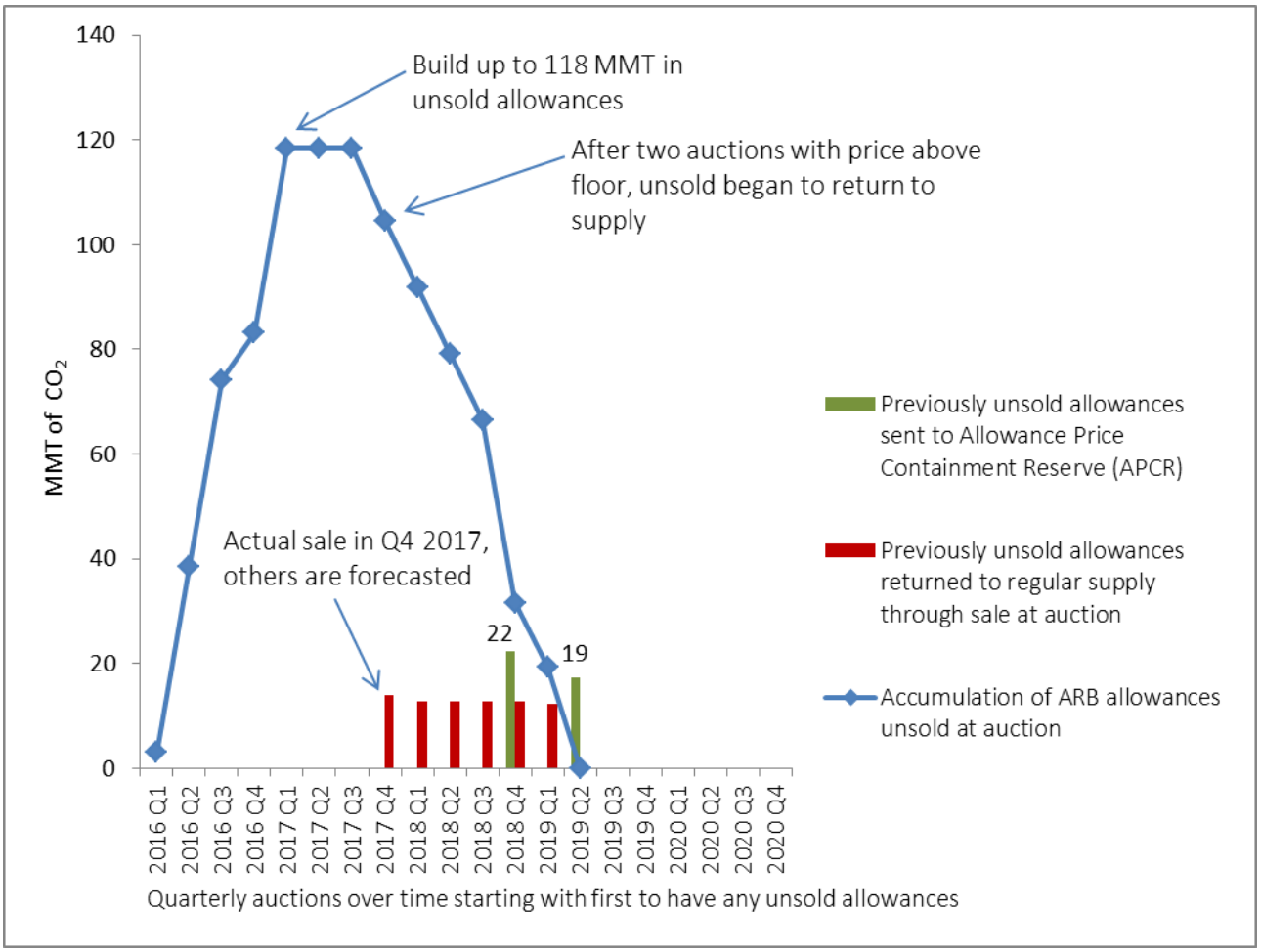

Figure 1. Accumulation and forecasted future disposition of currently unsold allowances

One nuance related to the effect of new rules on the future fate of unsold allowances that accumulated before the recent surge in demand involves CARB's announced plans to retire some allowances due to estimated emission leakage from the Energy Imbalance Market (EIM), which enables inter-state trading of electricity. While the EIM allows more efficient integration of high shares of renewable electricity, CARB's greenhouse gas accounting has not yet caught up to this mechanism. At a July California Senate hearing, CARB Deputy Executive Officer Steve Cliff said that CARB plans to retire approximately 15 MMT in allowances to account for potential leakage due to the EIM, and these may end up being taken from unsold allowances that would otherwise be destined for the APCR.

TREATMENT OF ALLOWANCE PRICE CONTAINMENT RESERVE

The APCR holds a 141 MMT supply of California and Quebec allowances taken from initial cap levels through 2020 before implementation began. As well, Ontario's regulation calls for five percent of each year's cap to their reserve equivalent to the APCR. These allowances are not factored into the estimation of oversupply through 2020 due to price expectations. The historical trend and research about future prices, discussed next, suggest that emissions and prices will not be high enough to trigger the release of allowances from the APCR. Essentially, while carbon prices are no longer at the floor price, they are still relatively low. And even though they are rising (reaching $15.06 at the fourth quarterly auction of 2017) there are no signs of pressure on carbon prices that point to prices rising to the level at which the allowances in the APCR would be accessed.

This price increase would have to be very large, due to substantial distance between the price floor and the prices needed to release APCR allowances. The APCR is structured with three tiers, each holding one-third of the total, and each with its own trigger price at which the allowances contained are to be released. In 2017, the price triggering the first tier of allowances was $50.69 per allowance, $57.04 per allowance for the second tier, and $63.37 in the third tier. These compare to a current price floor of auction reserve price of $13.57 per ton. The price floor and APCR tiers all increase at an annual rate of five percent plus inflation.

It is true that if emissions are high enough, covered emitters could be pushed far enough up the marginal abatement cost curve that prices would reach APCR trigger prices. However, almost by definition, this would only occur in the absence of significant oversupply, at least if due to emissions fundamentals.

While it is unlikely APCR allowances will be released before 2020, their introduction is more likely after 2020, once cap levels decline far enough. Therefore, discussions of the implications of oversupply through 2020 for post-2020 emission reduction efforts consider APCR allowances separately but in parallel with oversupply.

FUTURE PRICE EXPECTATIONS

The analysis does not generate original estimates of future prices, but draws on existing work in the literature. Future price expectations affect the propensity to bank allowances. The potential for APCR allowances to be released in the future is also linked to future prices.

Prices through 2020

Work by Borenstein et al. (2016) forecasts price expectations through 2020 using top-down, sector level data and macro drivers like state economic output and vehicle miles travelled. Their

work finds a 1.4 percent chance that any APCR allowances will be released before 2021 and only a 0.1 percent chance that all APCR allowances are released. [22]

Prior work, dating to 2009 and the collaborative modeling exercise organized by CARB, had forecasted prices of approximately $20 per ton. CARB's own modeling had estimated a 2020 price of $21 per ton and UC Berkeley's David Roland-Holst had pegged the 2020 price at $18 per ton.[23] Industry-funded work by Charles Rivers Associates was an outliner, predicting 2020 prices in the $50-80 per ton range.[24]

While prices have increased with passage of AB 398, they remain relatively moderate. The recent peak high secondary market price ($15.54 per current vintage allowance on the spot market on September 6, 2017) represents a premium of about 15 percent above the floor price, and the price has fallen by about 20-30 cents from that recent maximum.

Prices were relatively higher in the early years of the California program. In July of 2012, secondary market prices surpassed $20 per ton (e.g. $20.10 on July 24, 2012) when the price floor was $10 per allowance.[25] More recently, auction prices have been lower relative to the floor. The August auction price of $14.75 for current vintage allowances was nine percent above the $13.54 floor price, and the November price was 11 percent above the floor. May 2013 auction settlement price of $14.00 per allowance was 31 percent higher than the 2013 floor price of $10.71.[26]

Figure 2 shows price trends over time at auction and in the secondary market as well as the price floor and lowest APCR price, which both increase annually at five percent plus the consumer price index.[27]

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[22] See table 7, page 37 in: Severin Borenstein, James Bushnell, Frank A. Wolak, and Matthew Zaragoza-Watkins. 2016. Expecting the Unexpected: Emissions Uncertainty and Environmental Market Design, Energy Institute at Haas Working Paper 274 (August). https://ei.haas.berkeley.edu/research/papers/WP274.pdf

[23] ARB presentation of results: https://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/arb.pdf Roland-Holst results: https://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/rolandholst.pdf

[24] Charles River Associates results:

https://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/bernstein.pdf

[25] Historical secondary market price data from California Carbon Dashboard (http://calcarbondash.org/). The website is no longer updated, but historical InterContinental Exchange data through 2016 are available for download: http://calcarbondash.org/csv/output.csv.

[26] CARB. Auction Results Summary. https://www.arb.ca.gov/cc/capandtrade/auction/results_summary.pdf

[27] The APCR is currently separate in three tranches, each with a different price.

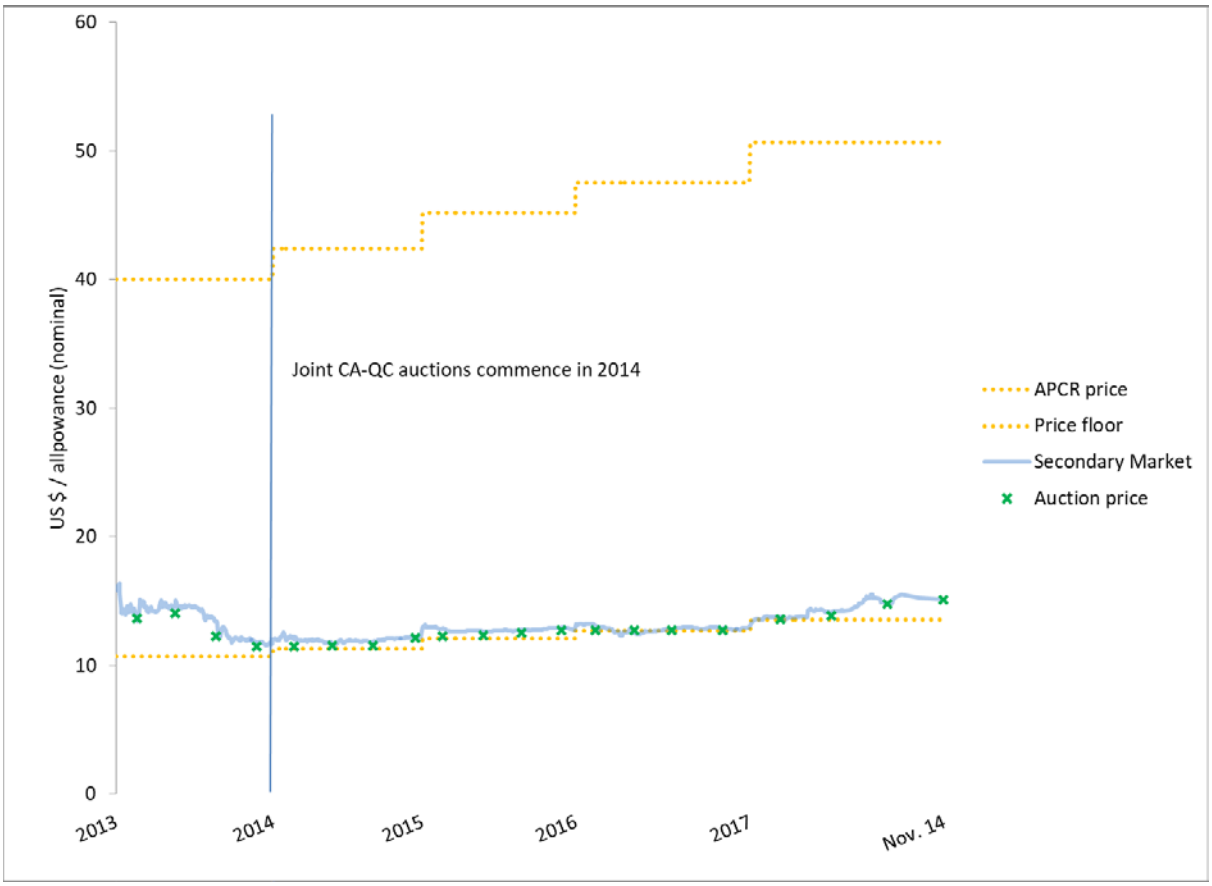

Figure 2. Auction and secondary market prices for current vintage allowances.
(Sources: California Carbon Dashboard, Intercontinental Exchange)[28]

Figure 2 shows that despite the increase after adoption of AB 398, prices are still close to the price floor.

Post-2020 price expectations

In sum, evidence suggests that long term carbon prices will be manageable but also high enough to encourage early purchasing as long as prices remain close to the floor.

Borenstein et al. estimate a 2030 price of $53.31 per ton in current dollars.[29] That is the central estimate (the probability weighted expected price) from their study, which produces a probability distribution for prices using econometric forecasting techniques. Their study

[28] These data are the prompt month or over the counter price for current vintage allowances. Each year's vintage has a slightly different price. Data are all directly or indirectly from the Intercontinental Exchange (ICE). Most of the historical secondary market price data from California Carbon Dashboard (http://calcarbondash.org/).

[29] Their central estimate is $51.62 in 2015 dollars, which we update to current dollars.

Severin Borenstein, James Bushnell, and Frank Wolak. 2017. "California's Cap-and-Trade Market Through 2030: A Preliminary Supply/Demand Analysis." (July) Energy Institute Working Paper 281

implicitly assumes that oversupply remains accessible as part of regular supply. Lowering future caps to account for oversupply would increase their price estimates. One factor biasing their costs upward is the lack of a production side response. No supply side adjustments are allowed, meaning producers neither switch to more energy efficient equipment, nor invest in lower carbon energy.

Work by David Roland-Holst also provides insights. In a 2015 paper, he conducted a policy 2030 policy. His work estimates a 2030 California carbon allowance price of $28 in current dollars for the scenario most resembling the 2017 Scoping Plan and finds positive over macroeconomic effects.[30] Professor Roland-Holst also conducted evaluations of the original Scoping Plan, and his forecasting proved more accurate than industry funded work by Charles River Associates.[31]

Proprietary analysis by National Economic and Research Associates, with the same model that Charles River Associates had used previously, has also circulated, showing much higher costs than the other studies discussed in the section.[32]

CARB's recent analysis has not involved forecasting allowance prices. Their economic modeling for the 2030 Scoping Plan explores the impacts of prices at the price floor and APCR price in 2030, taking these as given.

UPDATED OVERSUPPLY RESULTS

With methodology explained, we present results. Table 1 gives results for the mid scenario, as well as key sensitivities around future demand.

Estimated oversupply through 2020	Mid scenario (trend emissions)	Range due to high emissions and low emissions scenarios

[30] See figure ES-6 in the Roland-Holst paper for projected allowance prices. Relevant pathway is the "progressive scenario." Exact numerical values not provided, and so an approximation by visual inspection is discussed. $25 per to in $2010 amounts to $28 in current dollars. Roland-Holst's table ES-3 shows carbon pricing plus a strong vehicle electrification push to hit the 2030 target increases both Gross State Product and employment by two percent above the business-as-usual scenario.

David Roland-Holst. 2015. California Climate Policy to 2050: Pathways for Sustained Prosperity. Next 10 report (April 28) http://next10.org/sites/next10.org/files/FINAL%20Climate%20Pathways%202015.pdf

[31] As evident in presentations delivered to CARB on economic modeling of the Scoping Plan
https://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/outline.pdf
Roland-Holst presentation: https://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/rolandholst.pdf
Charles River Associates presentation https://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/bernstein.pdf

[32] The author has reviewed these results. Without explicit permission, I am not at liberty to discuss results in any details.

California and Quebec	290 MMT	220 – 360 MMT
Adding Ontario, i.e. WCI inclusive	270 MMT	200 – 340 MMT

Table 1. Updated cumulative oversupply estimate, 2016-2020

Table 1 and results in general are rounded to two significant digits so as to avoid the impression of extreme precision. These findings indicate significant oversupply and adding Ontario does not fundamentally alter the oversupply dynamic. Figure 3, below, lays the foundation for the graphical illustration of market balance by mapping supply and emission curves.

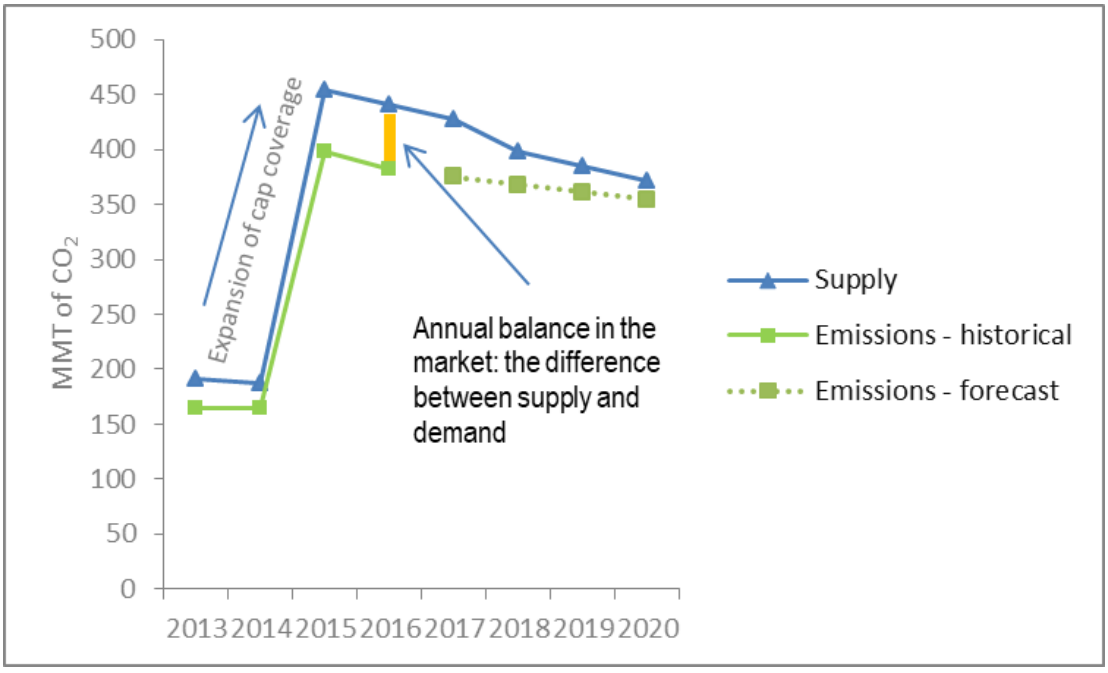

Figure 3. Market balance under trend demand forecast shows oversupply resolving in 2020.

Emission levels, representing compliance demand, are shown in green in Figure 3, with the solid line indicating historical (empirical) data and the dotted line representing the trend emission forecast, the mid-scenario for demand, which is the only one shown for simplicity. The high emission, high demand scenario would hold emissions steady at the 2016 level and in the low emissions scenario it would drop to 325 MMT in 2020. The blue line shows supply. Allowances attributed to each year reflect the actual cap levels from the total in the compliance instrument report, adjusting using the same accounting approach described above, for example removing allowances in the APCR.[33] The difference between the two, the annual balance in the market, is

[33] Allowances for the voluntary renewable energy set-aside are also removed from supply. Offsets use as explained in methodology section, actual submissions for 2013-2014 (about four percent) and five percent use for 2016-2020.

highlighted with the gold bar. With these supply and demand elements, we can track the annual and cumulative balance, shown in the next graph.

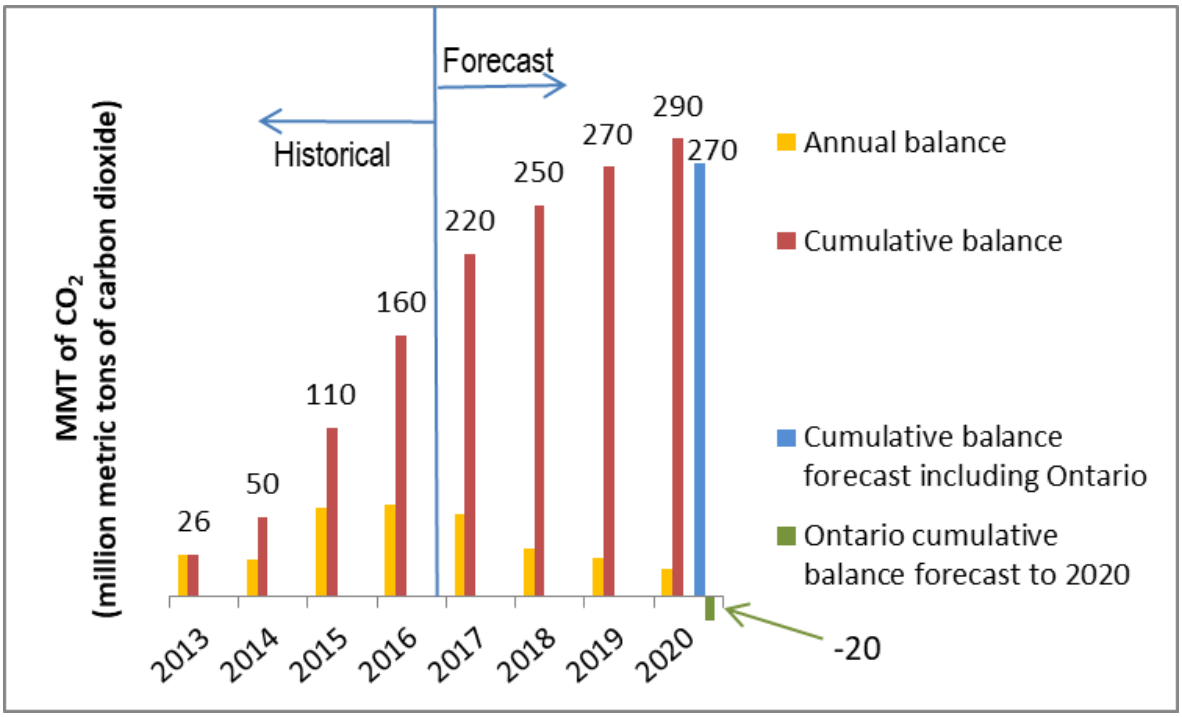

Figure 4. Annual oversupply appears to have peaked in 2016 but cumulative oversupply still climbing. Integrating Ontario does not change the basic outlines.

Figure 4 tracks the annual (gold bar, the same as in Figure 3) and cumulative market balance (red) over time. Under the mid-scenario for demand, annual oversupply peaks in 2016 at 58 MMT, falling to 52 MMT in 2017 and 17 MMT in 2020. An estimate of the cumulative balance in the Ontario market, negative 20 MMT, is shown in green.[34] The blue bar provides an integrated estimate for the WCI, pointing to 270 in oversupply cumulatively through 2020.

OFFSET SENSITIVITY ANALYSES

This section explores how different levels of offset use for the forecasted years (2016-2020) would affect cumulative oversupply through 2020.

[34] A market shortage for Ontario of 18.7 MMT was estimated by Sawyer, Dave, Jotham Peters, Seton Stiebert. "Overview of Macroeconomic and Household Impacts of Ontario's Cap and Trade Program," EnviroEconomics and NaviusResearch. May 2016.

	Cumulative oversupply through 2020 under mid-scenario emissions (MMT)	Cumulative oversupply range consider high – low emissions bounding scenarios (MMT)
Main case at 5% offsets use	270	200 – 340
Offset use sensitivities		
4%	250	180 – 320
6%	290	230 – 360
8%	340	270 – 410

Table 2. How different levels of offset use affect cumulative oversupply

Though future emissions are the most important determinant of overall market balance, Table 2 demonstrates that offsets play a nontrivial role. The range of oversupply across the range of emission scenarios considered amount to 140 MMT compared to 70 MMT across the offset sensitivities.

POTENTIAL USE OF ALLOWANCES IN APCR AFTER 2020

Rules around the use of allowances from the APCR are in flux as part of the re-consideration of cost containment required under AB 398, which provides new guidance around the setting of the price ceiling and two "price containment points" at which APCR allowances would be released.[35] Excluding APCR allowances from the oversupply calculation introduces conservatism to these estimates in the sense of not overestimating the impact of oversupply. While APCR allowances are held separate, depending on their price and the future price of allowances, they may be a factor in future market balance. Thus, a graph exploring future implications does portray APCR allowances.

The post-2020 supply of APCR allowances is estimated at 313 MMT based on the following:

- The APCR currently holds 141.8 MMT in California and Quebec allowances, taken from cap levels through 2020 as part of original design.
- Additionally, CARB will add 52.4 MMT in allowances to the APCR taken from cap levels over 2021-2030. In CARB's October 2017 workshop, staff asked for guidance on whether these should be made available at the price ceiling or the lower price containment points.

[35] AB 398 directs CARB to: "Establish two price containment points at levels below the price ceiling. The state board shall offer to covered entities nontradable allowances for sale at these price containment points. The price containment points shall be established using two-thirds, divided equally, of the allowances in the allowance price containment reserve as of December 31, 2017."

- Ontario has chosen to dedicate five percent of allowances from each cap for its cost containment mechanism which operates like the APCR. These add to 79 MMT over 2017-2030.[36]
- We understand the Canadian provinces are revising regulations to align with California's design, and so Quebec might well choose to add allowances to the APCR from caps over 2021-2030. Since we are not aware of any specific, confirmed plans in this regard, we do not assume any particular diversion of Quebec allowances to the APCR after 2020.
- A last element is the expected diversion of approximately 40 MMT in currently unsold California allowances to the APCR due to new rules discussed above.

THE RELATIONSHIP BETWEEN OVERSUPPLY AND BANKING

Before considering implications, it is necessary to touch on the foundational topic of how oversupply and banking interrelate. Banking is defined as the carrying forward of allowances from one year to the next by private entities. It is impossible to automatically draw a direct line between the amount of oversupply and the amount of expected banked allowances. However, in the case of the California-Ontario-Quebec market, it does seem reasonable all oversupply will be transformed into banked allowances for two main reasons. First, allowances do not expire, and hence can be purchased at lower prices for use later when prices are higher. Second, the aggressiveness of the post-2030 target and the emission reductions it will require are likely to cause future prices to rise. Therefore, our expectation is that all available allowances, even those above near-term compliance demand, will be purchased for future use.

Holding limits bound the amount of banking that any particular entity may undertake.[37] However, holding limits serve as a guard against the concentration of market power, which might allow market manipulation. Holding limits will not preclude the full banking of oversupply.

The 2017 holding limit was 12.6 MMT and the limit decreases to 11.6 MMT in 2020.[38] The holding limit is applied at the level of corporate association. Unlike the facility level data in mandatory reporting, these data are not public. Even if only 100 corporate associations are covered under the program, this would imply the potential for holding of up to 1,160 MMT in allowances – much larger than the maximum potential oversupply level. Furthermore, no limit on the number of third party actors (i.e. risk capital, hedging services) exists in the market. Therefore, holding limits would not preclude the full banking of oversupply available through 2020. CARB staff acknowledge this implicitly in explaining the purpose of holding limits in a

[36] O. Reg. 450/17, s. 28 at https://www.ontario.ca/laws/regulation/160144#BK76

[37] Emily Wimberger. 2016. "The Holding Limit for the California-Quebec Cap-and-Trade Programs," California Air Resources Board. (https://www.arb.ca.gov/cc/capandtrade/holding_limit.pdf)

[38] Ibid.

recent presentation: "Holding limits help ensure entities cannot create artificial allowance scarcity and price spikes via banking."[39]

The experience of the European Union Emission Trading System (EU ETS) shows that prices can remain robustly above the price floor (implicitly zero in their program) when strong confidence exists in long-term system demands even despite significant oversupply. By 2013, more than 2 billion tons of allowances had been banked in the EU system, but prices remained significantly above zero, in the range of €3-5 per ton and have recently climbed to about €7 per ton.[40]

LIKELIHOOD OF BANKED ALLOWANCE USE BY 2030

It is possible that some of the banked allowances available after 2020 could be carried over beyond 2030. One clear factor would push compliance entities to use banked allowances before 2030: the pathway that California has laid out is steepest during 2021-2030, twice as steep as during 2031-2050. This is true for both the aggregate statewide target and the reductions demanded under cap and-trade. Under cap-and-trade, the number of allowances falls by 13.3 MMT over 2021-2030, and thereafter caps are scheduled to fall by 6.7 MMT annually.[41] This reflects California's aggressive push to get halfway to its 2050 goal in one-third the time. In other words, half of the reductions planned for 2020-2050 are targeted for the first 10 years of the 30-year period, as Figure 4 illustrates.[42]

[39] CARB staff presentation. Cap-and-Trade Regulation Workshop. October 12, 2017. https://www.arb.ca.gov/cc/capandtrade/meetings/20171012/ct_presentation_11oct2017.pdf

[40] For a visual representation of the accumulation of banked allowances in the EU, see: Environmental Europe. 2014. *EU Stakeholders Divided Over Reforming EU ETS.* (June 26)

[41] These data are drawn from the newly adopted regulation, section § 95841. Annual Allowance Budgets for Calendar Years 2013-2050. See page 108 of the California regulation: https://www.arb.ca.gov/cc/capandtrade/capandtrade/unofficial_ct_100217.pdf

[42] Data for Figure 4 draw from source in footnote 41. 52.4 MMT that will be sent to the APCR are include in the cap levels shown in Figure 4.

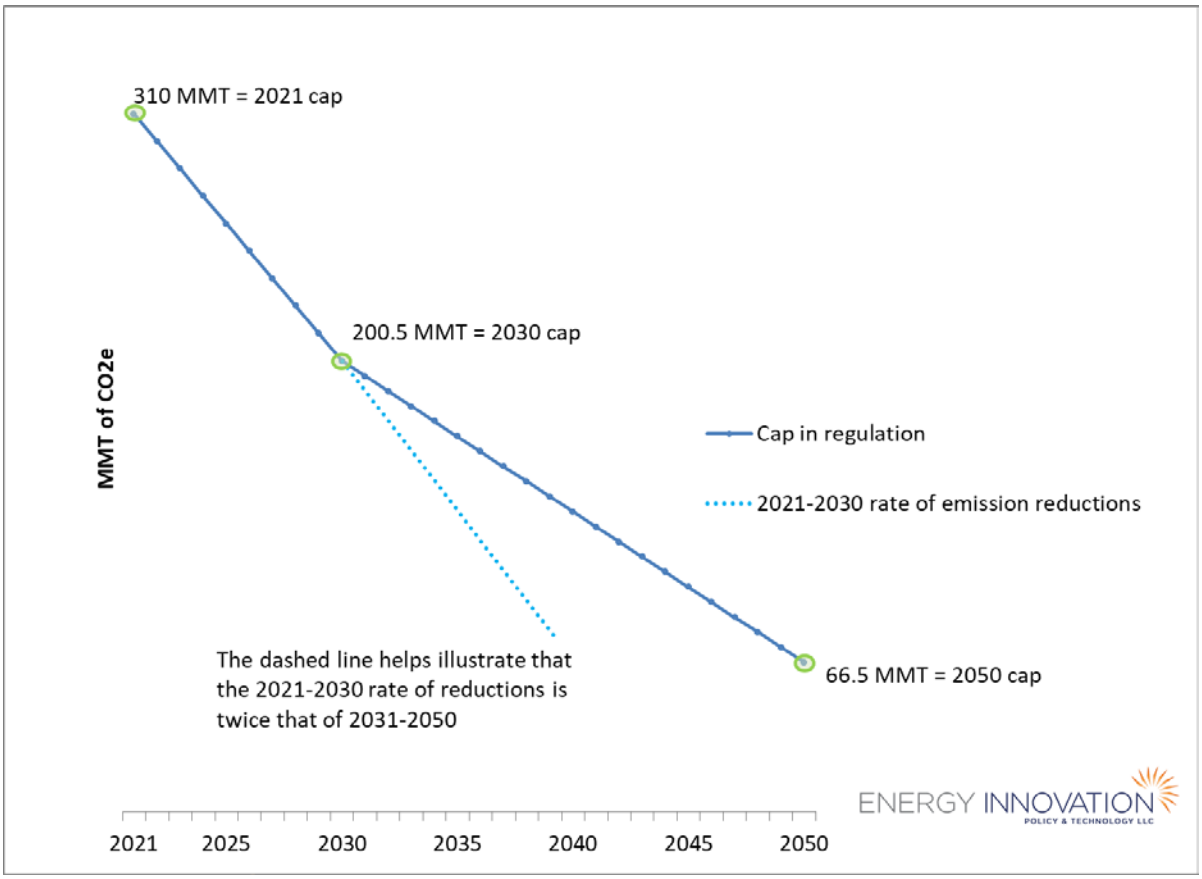

Figure 5. Faster reductions 2021-2030 compared to post-2030 trajectory

Figure 5 illustrates the steepness of the emission reductions called for in the 2020s compared to the next two decades. The line in the graph shows the cap levels under the cap-and-trade program, as distinguished from the statewide emission targets, such as SB 32's 40% below 1990 levels. CARB set the 2030 cap level of 200.5 MMT with the intention of hitting the 2030 target, identified as 260 MMT, which is pictured in Figure 5.

WHY OVERSUPPLY IS A PROBLEM IF LEFT UNADDRESSED

Current oversupply is a problem because, if left unaddressed, it will significantly depress the level of emissions reductions achieved by the WCI's cap-and-trade program after 2020. For California, which is relying upon cap-and-trade as the linchpin of efforts to achieve the emission reductions required under SB 32, oversupply risks the success of its 2030 strategy.

CALIFORNIA POLICY IMPLICATIONS

California is on track to achieve its 2020 target. The rate of emission improvement in the most recent mandatory emission data was greater than the level that will be needed in 2020s, when caps decline by 13.3 MMT annually. California emissions under the cap fell by more than 16 MMT in 2016 compared to 2015. These annual reductions exceed the pace that will be required to accomplish the aggressive 2030 target.

While a balanced assessment must recognize these positive trends, the threat posed by oversupply remains and deserves attention sooner than later. Indeed, faster than expected emission reductions, mostly due to factors other than cap-and-trade as discussed further in the section entitled, "Fortuitous over-compliance," increases the likelihood that oversupply will be large enough to dampen cap-and-trade's long term effectiveness.

The section "Fortuitous over-compliance" explores causal drivers of emission reductions under the cap-and-trade program. For the purposes of evaluating the policy strategy, the important point is that there are limits to how much longer these reductions will continue to accrue. Emissions associated with imported electricity fell to 20 MMT in 2016 compared to 30 MMT in 2017. It would only be possible for these reductions to continue at this level for two years. Put differently, reductions at this pace are unlikely to be sustainable by the current policy framework over the long term.

Looking forward, California is counting on cap-and-trade as the lynchpin of its 2030 strategy. The 2017 Climate Change Scoping Plan lays out the plan for achieving the SB 32-mandated 2030 target of 40 percent below 1990 emission levels[43] and presents analysis identifying cap-and-trade as the single largest driver of emissions. In the Initial Scoping Plan, cap-and-trade was expected to drive 20 percent of all emission reductions in 2020.[44] Cap-and-trade is expected to drive 236 MMT in reductions over 2021-2030, an estimated 38 percent of overall cumulative reductions below the latest business-as-usual scenario, taking the 2020 package of policies as given, as shown in Figure 6.[45]

[43] This document uses the abbreviated term, 2017 Scoping Plan, for the document with the full title:
2017 Climate Change Scoping Plan: The Strategy for Achieving California's 2030 Greenhouse Gas Target.
https://www.arb.ca.gov/cc/scopingplan/revised2017spu.pdf
We work from the most current version available at the time of release, dated October 27, 2017.

[44] See Table 3, page 22: https://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

[45] We work from the most recent version available at the time of publication of this report, which was released October 27, 2017. https://www.arb.ca.gov/cc/scopingplan/revised2017spu.pdf

Figure II-2. Scoping Plan Scenario – Estimated Cumulative GHG Reductions by Measure (2021–2030)[64]

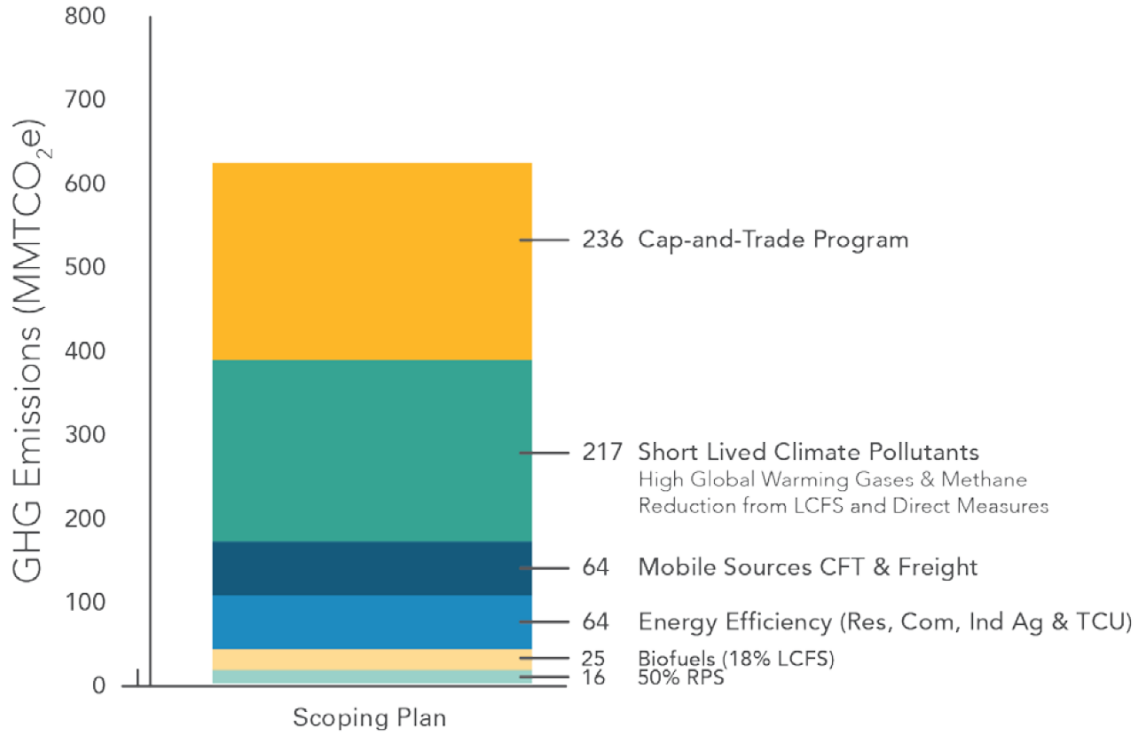

Figure 6. CARB's analysis of expected emission reductions by policy (or strategy) 2021-2030
(Source: CARB 2017 Scoping Plan, Figure II-2)

Figure 6 shows that cap-and-trade is the largest expected contributor to cumulative emissions reductions. Of course, many uncertainties exist in such a long run modeling exercise, and the Scoping Plan development process has given increasing attention to this. Previously, only uncertainty due to "sector policies" was discussed.[46] In CARB's estimation after factoring in uncertainty, the estimated reductions over 2021-2030 from sector policies (all those other than cap-and-trade) amount to 335 MMT (+/- 50 MMT), while cap-and-trade and trade drives 305 MMT in reductions (+/- 120 MMT). The details of CARB's uncertainty analysis were released after this report was largely completed and so it was not possible to include an in-depth consideration. However, it is clear that the Scoping Plan did not consider uncertainty due to the likelihood that banked allowances to spill forward after 2020.[47]

[46] The Initial Scoping Plan referred to policies other than cap-and-trade as "complementary" policies. The current draft 2017 Scoping Plan refers to these as prescriptive policies or known commitments.

[47] See list of factors contributing to uncertainty in the 2017 Scoping Plan, page 42.

CARB has generally promoted cap-and-trade over carbon taxes because cap-and-trade is meant to ensure quantitative certainty about emissions levels. This is still evident in some of the Scoping Plan language. For example, in the Proposed Scoping Plan under the policy assessment criteria evaluated in Table II-4, the "Ability to Reduce GHGs to Meet the 2030 Target" is put forth as an advantage of the cap-and-trade provides, stating: "The Cap-and-Trade Program scales to ensure reductions are achieved, even if other policies do not achieve them. This is particularly critical given the uncertainty inherent in both CARB's emission forecast and its estimate of future regulations."[48]

A new phrase added to the October draft of the Scoping Plan states: "As noted in the November 7, 2016, 2030 Target Scoping Plan Workshop, 'All policies have a degree of uncertainty associated with them,'" citing a presentation by Professor Jim Bushnell. Yet, the staff presentation from that day stated that the cap-and-trade program "is needed to achieve 2030 GHG target," because it is "uncertain if Alternative 2 [the carbon tax option] will meet 2030 GHG target."[49]

The new reference regarding uncertainty around cap-and-trade reductions seems to refer to the uncertainty around price elasticity effects.[50] While the price elasticity response expected from carbon pricing is indeed uncertainty, this seems to miss the point that it is possible to achieve emission certainty in a pure cap-and-trade system without any price controls. With proper enforcement, it is possible to achieve quantity targets with certainty under a tradeable permit system such as cap-and-trade.

While it is possible to achieve quantitative targets with certainty, it is not reasonable to expect policymakers to commit to emission reductions at any cost. A hybrid policy with some carbon price controls makes more sense. In particular, given the aggressiveness of the 2030 target, it makes sense to impose a hard price ceiling, as AB 398 does.

A final observation supporting the need to tune up the cap-and-trade program by adjusting for oversupply concerns the increasing constraints CARB faces with respect to other policies. The AB 398 deal adds some limits to CARB's authority, for example eliminating their authority to implement a rule that had been proposed targeting refineries and limiting CARB to Scoping Plan policies and strategies. Other legislation passed this year also adds new constraints. Senate Bill 1 limits authority over heavy duty vehicles, prohibiting the state from requiring them to retire or retrofit trucks before they reach 13 years old or 800,000 miles. Senate Bill 1383 prevents CARB from regulating methane from dairies and cattle farms prior to 2024. Moreover, the federal government is unlikely to be helpful, and to increase the stringency of the state's vehicles standards, a waiver would be required from the United States' Environmental Protection Agency.

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[48] From the proposed final scoping plan, Table II-4.

[49] Quotes from slide 8 at https://www.arb.ca.gov/cc/scopingplan/meetings/110716/economicspresentation.pdf

[50] The appendices supporting the 2017 Scoping Plan, including the key economic analysis Appendix E, were released on Friday, December 1st, after the final version of this report had been circulated for review. There was not enough time to include a thorough, thoughtful evaluation of the appendices in this report.

IMPLICATIONS FOR WCI'S CAP-AND-TRADE PROGRAM

Next the WCI implications are considered. A different perspective is taken from the California discussion, which benefits from the policy analysis associated with the 2017 Scoping Plan, providing estimates of reductions below the reference (or business-as-usual case) for cap-and-trade and other policies. Instead of comparing the effect that the use of banked allowances could have on emission reductions below the reference case, the effect that the banking of allowances could have in effectively increasing cap levels is explored.

Partly this is out of necessity as Ontario and Quebec do not have modeling that estimates forward-looking emission impacts below the reference case by policy type. However, an advantage of the approach is that it does not involve underlying reliance on a hypothetical counterfactual (the forecasted reference case) to establish emissions reduction. The result is a less theoretical evaluation that ties more closely to policy design in the sense that cap levels are a chosen parameter, and this perspective shows how banked allowances could affect these.

WCI cap levels have not been finalized, but the outlines are largely established. California has set cap levels to 2050 in regulation with rules approved in July 2017,[51] Ontario has adopted caps to 2030[52] and Quebec has published proposed caps.[53] WCI caps are simply the sum of all three.

With 2021-2030 WCI caps established, it is possible to calculate the difference between the intended levels in any particular year as compared to the 2020 cap and to add these up to find cumulative reductions in cap levels, summing to 760 MMT.

Estimated bank of 2020 vintage and earlier allowances available in 2021 due to oversupply[54]	APCR allowances	Cumulative emission reductions in cap levels below 2020 cap level 2021-2030
270 MMT in mid-scenario (uncertainty range 200-340)	313 MMT	760 MMT

Table 3. Comparing oversupply, APCR allowances, and reductions 2021-2030 under WCI cap

Table 3, shows that estimated bank due to oversupply is large compared to cumulative reductions below the 2020 cap. APCR allowances, which may or may not be released, depending

[51] https://www.arb.ca.gov/regact/2016/capandtrade16/ctfinro.pdf

[52] Ontario Regulation 144/16: The Cap and Trade Program under Climate Change Mitigation and Low-carbon Economy Act, 2016, https://www.ontario.ca/laws/regulation/160144

[53] Quebec caps from "Gazette Officielle due Quebec, August 31, 2017, Vol. 149, No 35A"

[54] As previously noted there is the possibility that some banked allowances could be held past 2030, though the aggressiveness of the 2030 target would provide an incentive for banked allowances to be used sooner.

on the price levels for new price triggers, are tracked separately from estimated oversupply. The next table converts estimated oversupply into a percentage of cumulative cap reductions.

Mid-scenario	Lower oversupply estimate	Higher oversupply estimate
35%	26%	45%

Table 4. Percentage of emission reductions under WCI caps below 2020 level foregone due to carrying forward of banked allowances after 2020

Table 4 shows that the expected bank of allowances accumulated through 2020 is 26 – 45 percent of cumulative WCI cap declines 2021-2030. Another way to think about the impact is that the banking of allowances through 2020 could effectively negate WCI cap reductions until 2025 or 2026.

To provide some further intuition about the potential impact, Figure 7 uses a very simple hypothetical scenario with steadily increasing use to show how banked allowances might be deployed.

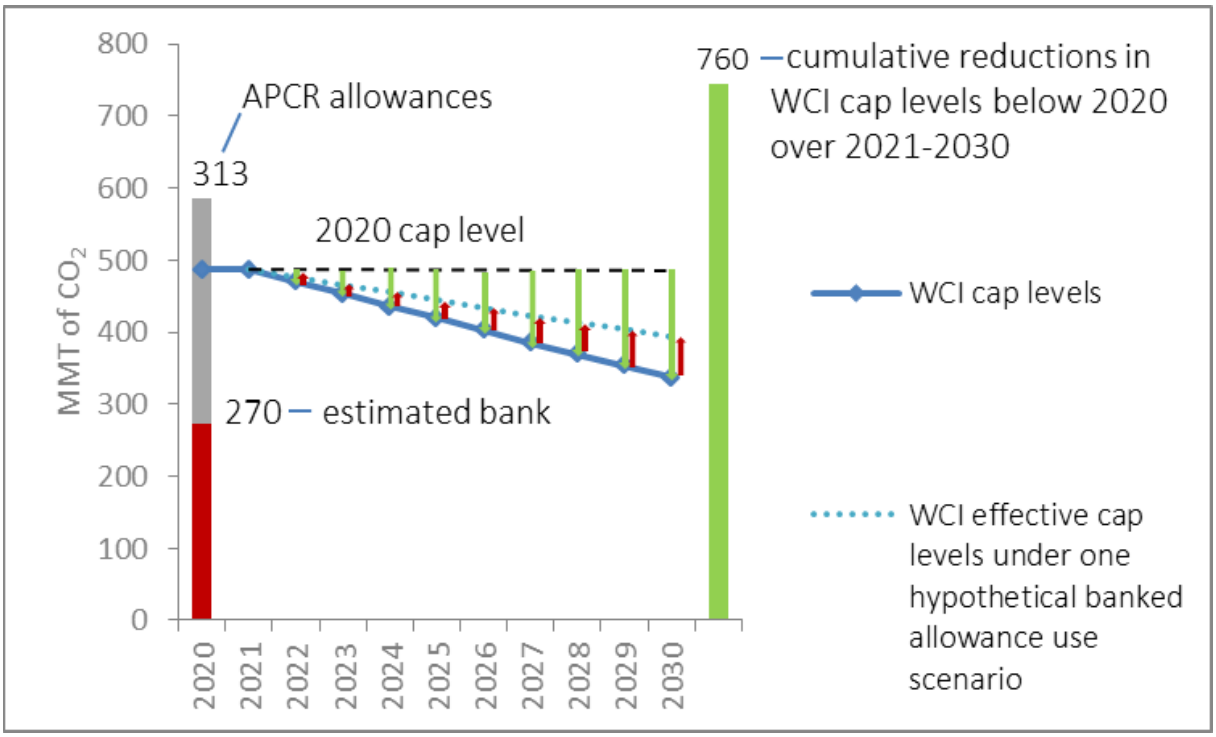

Figure 7. A hypothetical illustration of how banked allowance use could affect emissions

The dashed line shows how much this scenario would increase allowable emissions above intended cap levels, the blue line. The graph also depicts the estimated banked allowances accumulated by the end of 2020 (red bar, mid-scenario oversupply), APRC allowances (grey bar), and the cumulative reductions in cap levels 2021-2030 (green bar at right). In fact, the use of banked allowances is likely to be irregular and nonlinear. Overly simplistic though it is, the

hypothetical is included to impart some intuition with respect to the potential impact of banked allowances.

THE CAUSES UNDERLYING EARLY OVERSUPPLY

Economists are inclined to look favorably on banking as a rational market outcome. For example, MIT Professor Denny Ellerman and his colleagues argue that the bank accumulated under the EU ETS is not necessarily a problem:

> "For too long, the facile explanation of some structural or behavioral defect has been offered as an explanation in the public debate when the reality is more complicated and involves economic choices by optimizing agents. One key lesson of this analysis is that it is rational to decrease emissions below the cap at the start of the banking period and to accumulate a "surplus" in order to minimize abatement costs over time. The observed EUA bank at the end of Phase II falls within the range of values indicated by the illustrative simulations presented in this paper suggesting behavior by agents consistent with intertemporal cost minimization in a perfect-foresight model."[55]

Elsewhere, the paper makes clear they are not claiming they have proved that purposeful early action drove the accumulation of the EU ETS bank, only that it is possible.

It seems clear that EU ETS policymakers disagree and found the large bank to be problem. Their creation of a "Market Stability Reserve" added high side cost controls, while also helping to resolve their oversupply problem. Essentially, the Market Stability Reserve reduces future supply, unless the market tightens beyond certain performance metrics (price or liquidity).

Just as in the EU ETS, factors other than emission reductions in anticipation of future emissions reductions under cap-and-trade are the main causes of emissions having fallen so far below cap levels. Clearly, the economic recession played a role in easing the 2020 compliance pathway. Statewide emissions dropped a record 29 MMT in 2009, as the economic downturn was hitting full force, more than three times larger than reductions in any other year.[56]

As the economy bounced back, emissions continued to decline, helped along by faster than expected progress in other policies, supported by rapid innovation in renewable electricity technologies.[57] The electricity sector's strong decarbonization performance, spurred on by

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[55] Denny Ellerman, Aleksandar Zaklan, and Valero Vanessa. 2015. "An Analysis of Allowance Banking in the EU ETS." http://cadmus.eui.eu/bitstream/handle/1814/35517/RSCAS_2015_29.pdf?sequence=1&isAllowed=y

[56] CARB. 2017. Greenhouse Gas Inventory https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_sum_2000-15.pdf

[57] For example, as of 2017, California has already reached its utility performance standard for 2020 requiring at least 33 percent renewables in the delivered electricity. This renewable electricity supply does not even account for the large amount of rooftop solar PV installed in California. Danny Cullenward also points out the likelihood that some

sector policies and renewable energy innovations that have made these the lowest cost options in some contexts, has also played an important role.

While the broad emission reduction figures are encouraging, digging in more deeply to the trends reveals some trouble spots.[58] Recent emission reductions have been almost entirely in the electricity sector. Transportation emissions under the cap rose in 2016 for the second year in a row.

The fact is that no researcher has yet to rank, much less identify quantitatively the causal effects, of each of the individual policies in the original Scoping Plan. CARB's ex-ante estimate that cap-and-trade would produce 20 percent of reductions is more than a decade old. Despite the clear existence of oversupply, the robust price floor ensures a minimum carbon price. Hence, it would be incorrect to conclude that the program is not having any effect.

The method that Severin Borenstein and colleagues have used to forecast future prices impacts is adapted to develop a backward looking estimate of reductions due to the cap-and-trade program.[59] Borenstein et al. apply price elasticities of demand for transportation fuels, natural gas use, and electricity to approximate future responsiveness to carbon pricing. The same approach is applied retrospectively to actual data on energy use and prices to estimate an effect from the cap-and-trade program in 2015 and 2016.

	Reductions based on low end of price elasticity range	Reductions based on high end of price elasticity range
2015 estimated reductions	1.7 MMT	3.3 MMT
2016 estimated reductions	1.7 MMT	3.4 MMT

Table 5. California emission reductions in carbon dioxide emission due to cap-and-trade [60]

emissions inherent in imported electricity have not been counted due to some accounting difficulties and past program design choices, a phenomenon known as resource shuffling. For more on reshuffling, see:

Danny Cullenward and Andy Coghlan. 2016. "Structural oversupply and credibility in California's carbon market," The Electricity Journal29(5): 7–14

[58] For more discussion of recent trends, see: Danny Cullenward, Mike Mastrandrea, and Mason Inman. 2017. *California's climate emissions are falling but cap-and-trade is not the cause.* http://www.nearzero.org/wp/2017/11/10/californias-climate-emissions-are-falling-but-cap-and-trade-is-not-the-cause/

[59] Severin Borenstein, James Bushnell, Frank A. Wolak, and Matthew Zaragoza-Watkins. 2016. *Expecting the Unexpected: Emissions Uncertainty and Environmental Market Design*, Energy Institute at Haas Working Paper 274 (August). https://ei.haas.berkeley.edu/research/papers/WP274.pdf

[60] The method used to estimate reductions from cap and trade in 2015 and 2016 as presented in this table starts with the definition of elasticity:

It is important to recognize that the method carried out to calculate the results in Table 5 is limited by its consumption focus. It does not fully capture production side adjustments that would be expected due to availability of renewable and energy efficiency options. While incomplete, some information is better than no information. And no other ex-poste analysis of reductions due to the WCI cap-and-trade program exists. These results generally correlate with the conclusion that factors external to cap and trade have been the main driver of oversupply.

HOW OTHER PROGRAMS HAVE ADJUSTED TO OVERSUPPLY

Both the EU ETS and RGGI have taken steps to adjust cap levels to account for oversupply.

In 2014, RGGI states lowered caps by 140 MMT to account for excess allowances sold and banked from 2009-2013. The adjustment is illustrated in Figure 8 with green arrows indicating the cap lowering that occurred to account for prior banking.

$$\varepsilon = \frac{\%\Delta Q}{\%\Delta P} = \frac{\frac{Q_0 - Q_1}{Q_0}}{\frac{P_0 - P_1}{P_0}}$$

$\mathcal{E}$ = elasticity. Estimated, with values taken from Borenstein et al. (2016).
P_1 is known, price of energy observed (average for the years 2015 and 2016)
ΔP is known, assumed to equal carbon price (per full cost through assumption in the paper). These results account for free allocation to natural gas deliverers, a difference from Borenstein et al.
Therefore, P_0 is calculable, using $\Delta P = P_1 - P_2$
Q_1 is known (actual energy consumed).
Therefore equation 2 has only one unknown, Q_0, and through algebraic manipulation we can show

$$Q_o = \frac{Q_1}{\varepsilon * \frac{P_0 - P_1}{P_0} + 1}$$

With this, the change in fuel combusted (transportation fuels and natural gas) or consumed (electricity) can be calculated.
Next, carbon intensity of fuels is applied to estimate emission reductions.

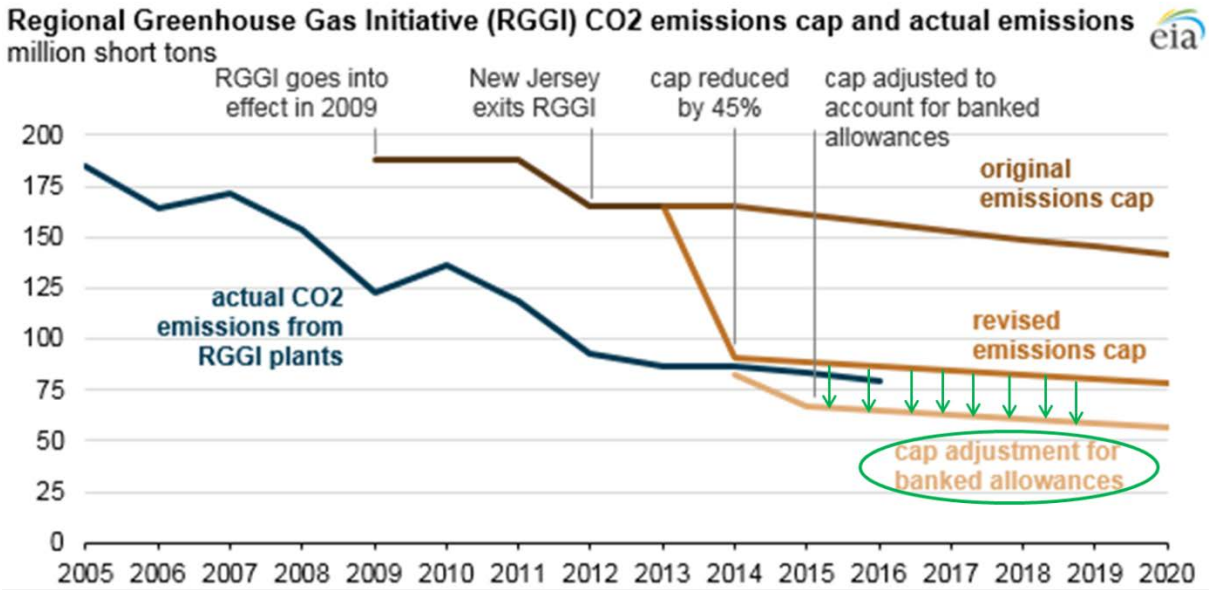

Figure 8. Lowering of cap to account for banked allowances in RGGI
(Source: U.S. Department of Energy, Energy Information Administration[61])

Recently, as part of a comprehensive review of the program and cap levels, RGGI has announced plans to undertake another cap adjustment to account for additional banking of allowances through 2020. "Proposed improvements include making… [a]dditional adjustments to the RGGI cap, to account for the full bank of excess allowances at the end of 2020. The amount of this adjustment will be calculated in 2021 according to a formula to be established in the revised Model Rule, and it will be implemented over the period from 2021-2025."[62] As proposed, this adjustment would work in the same way as the RGGI states' earlier adjustment, resulting in lowered 2021-2025 cap levels (i.e., fewer allowances made available for sale in future periods) to account for the size of the bank.

The EU ETS has also grappled with oversupply, and more than 2 billion tons of carbon allowances had been banked under the system by 2013.[63] The EU's long term response essentially involves lowering future cap levels, done in a way that helps simultaneously solve the lack of explicit cost containment in the program. Some allowances were diverted into a "market stability reserve"

[61] https://www.eia.gov/todayinenergy/detail.php?id=31432&src=email

[62] RGGI Inc. 2017. "RGGI States Announce Proposed Program Changes: Additional 30% Emissions Cap Decline by 2030," press release. August 23.

https://www.rggi.org/docs/ProgramReview/2017/08-23-17/Announcement_Proposed_Program_Changes.pdf

[63] "The surplus amounted to around 2 billion allowances at the start of phase 3 [in 2012] and increased further to more than 2.1 billion in 2013." European Commission website accessed 11 September 2017. https://ec.europa.eu/clima/policies/ets/reform_en

which will operate somewhat like the APCR in the WCI. If prices rise above or market liquidity drops below pre-determined levels, then allowances are to be released.

The EU ETS's approach going forward is different than how the program addressed oversupply in the first phase of the program (2005-2007). In that instance, no banking was allowed from the first phase to the second phase. This caused the price of allowances eligible for first phase compliance to crash to zero. This induced price volatility, and the recognition that disallowing banking creates a "use it or lose it incentive" (if the allowance is not used, it eventually becomes worthless), had led to the different, forward-looking cap adjustment approach now in favor.

RECOMMENDATIONS

To account for oversupply, California and the WCI should adjust caps for 2021-2030 downward in an amount equal to the sum of 2020 and earlier vintage allowances that remain privately held after emitters have finished submitting allowances for compliance through the end of 2020.

This straightforward adjustment to program design, tested and proven effective by RGGI, can resolve the issue. Because it involves adjusting future caps downward to account for the amount of allowances banked, this approach does not negatively affect private holdings of allowances and it does not involve a change in banking rules. It does not encourage greater volatility and it only increases the incentive for early action.

Energy Innovation first urged this approach in an April 2017 comment letter on the CARB Scoping Plan in April, when we recommended:

> *"After the third compliance period ends, adjust future caps downward in an amount equal to the size of the [private] bank of 2020 and earlier vintage allowances."*[64]

CARB and the WCI should also adopt a specific schedule for program review. These regular reviews – we suggest at the end of each compliance period – should evaluate cap-and-trade program performance. The October draft of the 2017 Scoping Plan increases the emphasis on periodic reviews but is short on specifics, beyond noting the five-year Scoping Plan cycle.

Some might protest that reducing the supply of allowances would increase carbon prices. While a higher carbon price indicates higher compliance costs for emitters, it does not necessarily equate to higher social costs. Higher carbon prices offer two important benefits almost invariably left out of economic analyses: (1) greater public health benefits, including reduced health care costs, better student performance, and higher worker productivity, and (2) greater competitiveness for domestic clean technology companies, which are then more likely to capture a larger share of the fast growing international market for clean tech.

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[64] Full comment letter available at:

https://www.arb.ca.gov/lists/com-attach/204-scopingplan2030-AmcHb1QwUHEKawR9.pdf

In addition, California's initial experience points to the positive coexistence of declining carbon emissions and robust economic growth. And despite the cost bias inherent in economic modeling, some studies indicate meeting the 2030 target will have overall economic benefits. Nonetheless, since the 2030 target is much more aggressive than the 2020 target, it is appropriate for policy design to acknowledge uncertainty. AB 398 is helpful in this regard, requiring the establishment of a hard price ceiling, guaranteeing carbon prices will rise no higher than that ceiling. This should provide policymakers the confidence to correct for early oversupply.

CONCLUSION

The WCI cap-and-trade program is the best designed in the world, not least because its price floor is the highest. While oversupply itself does not represent a mistake, it would be a mistake to not adjust to oversupply. There is no guarantee that the price floor will deliver the necessary emissions reductions. Rather, if left unaddressed banked allowances due to oversupply would be expected to effectively raise the WCI cap levels for 2021 and later substantially above the caps proposed in regulation.

APPENDIX: FURTHER DETAILS ON METHODS

This appendix provides a guide to the spreadsheet developed to carry out the methodology described above. The spreadsheet documents the mathematical calculations entailed. The notes below provide a narrative description and discuss data sources. Worksheet names are in bolded, italic text. As noted under the supporting documentation section, the spreadsheet is downloadable at the following link:

http://energyinnovation.org/wp-content/uploads/2017/12/WCI_market_balance_evaluation.xlsx

"1. demand-emission data"

This spreadsheet brings together mandatory reporting data on emissions for covered sources for 2013-2016 from. Source data:

> The Quebec Ministry of Sustainable Development, Environment, Wildlife and Parks: http://www.mddelcc.gouv.qc.ca/changements/carbone/ventes-encheres/listeetablissements-visesRSPEDE.pdf
>
> The California Air Resource Board: https://www.arb.ca.gov/cc/reporting/ghgrep/reported-data/ghg-reports.htm

These empirical data are the basis for the future emissions forecast. The data show annual declines of 0.8 percent, 1.0 percent, and 4.0 percent. The "trend emissions" approximates this as a reduction of 1.9 percent annually. As explained in the original recalibrating report, this historical trend is bounded at +/- one percent, providing high and low demand scenarios.

The user can specify different bounds, by changing the rate of emissions decline (or even contemplating increasing emissions) by changing the values in the cells B17, C17, D17.

"2. supply data – privately held"

Next, the joint California-Quebec compliance instrument report provides raw data on what allowances are in private hands and what have yet to be distributed. The most recent version of that report is always posted at:

https://www.arb.ca.gov/cc/capandtrade/complianceinstrumentreport.xlsx

It is also necessary to adapt data in the compliance instrument report (with data from April) to reflect the results of the May auction. Purchased allowances from the May auction are added to the supply of privately held allowances.

"3. supply data - retirement"

Another aspect of establishing the destruction of supply involves establishing how many allowances have already been retired for the second compliance period. This involves summing up the retired allowances in the compliance instrument report, and then subtracting what was submitted for 2013-2014 compliance, as indicated in the compliance instrument report from the first compliance period.

The 2013-2014 compliance instrument report can be found at:
https://www.arb.ca.gov/cc/capandtrade/2013-2014compliancereport.xlsx

"4. supply data – future"

The future supply data are found in the relevant parts of the compliance instrument report: Column F provides data on allowances still slated for distribution through 2020: Auction + Issuance + Allocation

It is necessary include in future supply allowances from the "limited use holding account," which are allowances that will be made available through future consignment auctions. Allowances from the ACPR are not included in this or any component of market balance through 2020.

"5. unsold allowances to reserve"

This worksheet calculates the number of unsold allowances expected to be sent to the ACPR. New rules require CARB to deposit unsold ARB allowances if they have remained unsold for two years. The first part of the worksheet identifies unsold ARB allowances by date when they first went unsold. Auctions results are accessible here:
https://www.arb.ca.gov/cc/capandtrade/auction/auction.htm

The next piece of the analytical puzzle is future auction levels. These must be estimated to apply the 25 percent rule by which previously unsold allowances will be rolled back in at future auctions. Thanks to Dan McGraw of ICIS for providing estimates of future auction levels for California allowances.

With these components, it is possible to mechanically crank through how quickly previously unsold allowances could return to auction, and what number would not return to auction fast enough to avoid diversion to the ACPR.

"6. supply aggregation"

This worksheet adds up the components of allowance supply: those retired; those in private hands; those in government hands, and; factoring in the diversion of unsold allowances to the ACPR.

"7. offsets"

This worksheet calculates the use of offsets under the different demand scenarios.

We evaluate a five percent offsets scenario and report a range of sensitivity results for offset use. Changing the value in cell B2 tests the implications of different offset levels.

"8. synthesis"

The market balance is estimated as the difference between the supply of compliance instruments and compliance demand (emissions).

DISCLAIMER

The report endeavors to use the most credible sources and to employ transparent, reasonable assumptions. Two rounds of peer review were undertaken to test findings. Perfect accuracy or absolute completeness cannot be guaranteed. Any opinions expressed reflect the current judgment of the author and are subject to change without notice. The purpose of this work is to influence the policy dialogue and not to offer investment advice. Energy Innovation: Policy and Technology, LLC accepts no responsibility for any liability arising from use of this document or its analytical underpinnings.