

**DRAFT FINAL 2022 AQMP
COMMENTS AND RESPONSES TO COMMENTS
ON APPENDIX I – HEALTH EFFECTS**

NOVEMBER 2022

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Table of Contents

- **Preface** 1
Overview of public comments
- **Comment Letters and Staff Responses** 2
Staff responses to comment letters on Appendix I – Health Effects

Preface

A total of six (6) comment letters have been received on the Appendix I – Health Effects of the Draft 2022 AQMP. These six comment letters were received through August 15, 2022.

This document consists of one covering staff responses to specific comments. Comments are in black and staff responses are in *italic red*.

TABLE 1
COMMENT LETTERS

Comment Number	Commentor Name	Representing	Date Received	Time Received
81	James Enstrom	Scientific Integrity Institute	6/7/2022	15:16
82	Natalie Hernandez	Climate Resolve	8/10/2022	12:47
83	Jo Kay Ghosh	Heluna Health	8/11/2022	19:05
84	Xiangmei (Mei) Wu	Office of Environmental and Health Hazard Assessment	8/12/2022	8:44
85	Gregory Osterman	Jet Propulsion Laboratory, NASA	8/13/2022	14:44
86	Bonnie Holmes-Gen	California Air Resources Board	8/15/2022	17:54

Staff has also summarized and responded to verbal comments at the two meetings held to discuss Appendix I on August 10, 2022 and more briefly on October 5, 2022. The presentations¹ and minutes² of these meetings can be downloaded from the South Coast AQMD website.

¹ South Coast AQMD Advisory Council website: <https://www.aqmd.gov/nav/about/groups-committees/aqmp-advisory-group/advisory-council---aqmp>.

² August 10, 2022 meeting minutes: <http://www.aqmd.gov/docs/default-source/Agendas/advisory-council/advisory-council-minutes-08102022.pdf?sfvrsn=8>; October 5, 2022 meeting minutes to be available soon.

Comment Letters and Staff Responses

Comment Letter #81

From: JAMES ENSTROM <jenstrom@ucla.edu>
Sent: Monday, June 13, 2022 10:00 AM
To: Ian MacMillan
Cc: Nichole Quick; Elaine Shen
Subject: June 7 STMPR Zoom & June 8 EPA CASAC Ozone Comment
Attachments: Enstrom Comment to EPA CASAC Ozone Panel HR 060822.pdf; CA Open Letter to CARB on Climate Policy Impacts 060822.pdf; CA Auditor Report 2020-114 on CARB & Climate Goals 022321.pdf

June 13, 2022

Dear Ian,

As a follow-up to our June 7 STMPR Zoom Meeting, I request that you read my attached June 8 Comment to the EPA CASAC Ozone Review Panel and the twelve weblinks that it contains. The six major points in my comment are highly relevant to the 2022 AQMP. I have substantial evidence that personal exposure to ozone and PM2.5 for most people in the SCAB is well below the NAAQS for ozone (70 ppb) and PM2.5 (12 ug/m3). If instance, at my home near UCLA my ozone meter consistently shows an indoor level of about 10 ppb and a maximum outdoor level of 30 ppb. You must measure ozone and PM2.5 levels in your AQMD offices for comparison with my levels and the levels stated in the AQMP.

In addition, I have attached the June 8 CA Open Letter to CARB opposing the proposed CARB Climate Change Scoping Plan. I have substantial evidence that this Scoping Plan is scientifically unjustified, economically devastating, and in many ways illegal. Finally, I have attached the February 2021 CA Auditor Report on CARB, which documents that CARB has not demonstrated the effectiveness of its programs in reducing GHG emissions and providing Socioeconomic Benefits to Californians.

I look forward to working with you and using my epidemiologic expertise to improve the 2022 AQMP.

Thank you very much for your interest and consideration.

Best regards,

Jim
James E. Enstrom, PhD, MPH, FFACE
Retired UCLA Research Professor (Epidemiology)
<http://scientificintegrityinstitute.org/>
jenstrom@ucla.edu
(310) 472-4274

June 8, 2022

US EPA CASAC Ozone Review Panel Regarding Ozone NAAQS Reconsideration
https://casac.epa.gov/ords/sab/f?p=113:19:8532987399969:::19:P19_ID:972
https://youtu.be/5Qsqhqb5_F0 (minutes 20-26)
<http://scientificintegrityinstitute.org/OzonePanel060822.pdf>

Dr. James Enstrom's Verbal Comment to EPA CASAC Ozone Review Panel

I am Dr. James Enstrom. I have had a long career as an epidemiologist at UCLA and I have made significant contributions to air pollution epidemiology, particularly regarding the importance of transparency and reproducibility. The 2000 EPA CASAC, the 2000 EPA Administrator, and the [April 2022 EPA Ozone Policy Assessment Reconsideration](#) all recommended that the ozone NAAQS remain unchanged at 70 ppb. Thus, the Ozone Panel should not reconsider the ozone NAAQS at this time, but should reconsider it later during the regular 5-year review cycle. Instead, the Ozone Panel should assess six fundamental aspects of the science underlying the NAAQS.

1. Assess the extensive criticism of the linear no-threshold (LNT) model and estimate the threshold below which ozone has no adverse human health effects. U Massachusetts Professor Edward Calabrese published a May 17, 2022 "LNTGate" critique of LNT (<https://doi.org/10.1016/j.cbi.2022.109979>). It illustrates how acceptance of the LNT dose-response model was unethically advocated and advanced in the 1950s by key scientists and by *Science*, America's leading science journal. Unfortunately, *Science* will not acknowledge errors in four historical articles that are cornerstones in acceptance of the LNT model.
2. Assess the human health effects of ozone based on actual human exposure to ozone, not on the readings of ambient air monitors (<https://doi.org/10.1016/j.envint.2018.07.012>). There is extensive published evidence that most Americans are personally exposed to less than 20 ppb of 8-hour ozone because they spend up to 90% of their time indoors (<https://doi.org/10.1111/ina.12942>). In addition, the average seasonal 8-hour maximum ozone concentration in 2019 in the US was 43 ppb (<https://www.stateofglobalair.org/air/ozone>). The average indoor and outdoor ozone levels are both far below the current ozone NAAQS of 70 ppb (1.0 ppb~2.0 µg/m³). Thus, most Americans are not exposed to unhealthy levels of ozone.
3. Assess the extreme publication bias against null air pollution health effects findings by examining key null findings that have been ignored by EPA. My December 10, 2021 CASAC PM Panel comment (<http://scientificintegrityinstitute.org/PMpanel121021.pdf>) and my February 25, 2022 CASAC PM Panel comment (<http://scientificintegrityinstitute.org/PMpanel022522.pdf>) document that the 2021 PM ISA and PA ignored at least 60 authors, including me, who have published null findings or criticized the PM2.5 NAAQS. Similar publication bias exists regarding the ozone NAAQS.
4. Assess the evidence that ozone health effects must be based on findings that are transparent and reproducible. My 2017 and 2018 reanalyses of the ACS CPS II cohort found serious flaws in the seminal Pope 1995 article and the 2000 HEI Reanalysis and demonstrated the importance of access to underlying data (<http://scientificintegrityinstitute.org/DRPM25JEEPope052918.pdf>). However, *Science* Editor-in-Chief Holden Thorp recently demonstrated his strong bias against EPA transparency by personally stating to me that he will not publish any evidence that I submit to *Science* that supports "Strengthening Transparency in Regulatory Science" (<http://scientificintegrityinstitute.org/ThorpJEE041822.pdf>).

5. Assess the evidence that the ozone NAAQS is so low that it is impossible to ever reach attainment in many areas, especially in California. The April 15, 2022 SCAQMD Notice of Intent to sue EPA is necessary because it is impossible for the South Coast Air Basin to attain the 1997 Ozone NAAQS of 80 ppb without massive emissions reductions from Federal sources not controlled by SCAQMD (<http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/final-2016-aqmp>). EPA must recognize that California is a very healthy area of the US and that the current clean air in California is not harming its citizens (<http://scientificintegrityinstitute.org/AQMPJEE081516.pdf>). Overregulation by EPA is hurting California both scientifically and economically.

6. Finally, CASAC Panel members must recognize the different interpretations of weak epidemiologic evidence and engage with critics like myself. Simply note the difference between the 2020 CASAC and the 2022 CASAC regarding the assessment of the same PM2.5 data (<https://junkscience.com/2021/10/former-casac-chair-added-as-plaintiff-in-young-v-epa/>). It is important that you assess evidence objectively, keeping in mind the above points. This request is particularly critical at a time when the US faces a serious energy crisis that is made worse by unjustified EPA regulations on ozone and PM2.5.

Thank you very much.

James E. Enstrom, PhD, MPH, FFACE
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jenstrom@ucla.edu](http://scientificintegrityinstitute.org/jenstrom@ucla.edu)
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From: **Dr. Harvey Risch** <harvey.risch@yale.edu>
Date: Thu, Jun 9, 2022 at 8:19 PM
Subject: Comment re: EPA CASAC Ozone Panel
To: Yeow, Aaron <yeow.aaron@epa.gov>

Because EPA regulations have a major impact on life in America, they need to be based on the best scientific methods and include all relevant public health evidence. Thus, assessment of ozone health effects must properly address the following important issues: 1) threshold for human health effects, 2) actual human exposure, 3) publication bias against null findings, 4) transparency and reproducibility of findings, 5) realistic attainment levels, and 6) alternative interpretations of health effects evidence. Specific details regarding these six issues are contained in the June 8, 2022 EPA CASAC Ozone Panel Public Comment of Dr. James Enstrom. Please consider very seriously what Dr. Enstrom discussed. Thank you.

Harvey Risch

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OPEN LETTER TO CARB ON UPCOMING CLIMATE POLICY REGULATIONS



California Air Resources Chair Liane M. Randolph and Board Members
1001 I Street
Sacramento, CA 95814



Dear Board Members,



As California businesses begin to emerge out of the devastating COVID-19 pandemic that impacted every facet of our lives, we are now facing another major challenge - unprecedented energy costs. Some of these higher energy costs are certainly the result of the Russian invasion of Ukraine. However, the premium Californians pay for all forms of energy is also unquestionably the result of California's energy and climate policy design.



Governor Newsom and Legislators have proposed immediate action to get money directly into the pockets of Californians facing higher energy costs. At the same time, this Board is on track to adopt major regulations over the next few months that have the potential to drive businesses out of California, resulting in job losses, increase cost of living – including food, utilities, and housing costs – and major declines in economic activity.



We collectively have deep concerns with the direct negative impacts from the Climate Change Scoping Plan to meet the AB 32 emissions mandate and the Advanced Clean Cars Rule (ACC II), both of which you will be considering over the course of the coming months.



The decisions made and the path chosen will have a profound impact on all Californians, dictating how they must run their businesses, what cars they can drive, where they can live, and what stove they can cook with. Life as we know it in California will be altered going forward.

ACC II and the Scoping Plan will have major implications for businesses and individuals in California, including:



- **Higher utility costs** disproportionately impacting inland and rural communities
- **Eliminating consumer choice** by mandating all electric vehicles, appliances, residential and commercial buildings
- **Worsening our electric grid reliability** by pushing electrification without the infrastructure in place, thus increasing the likelihood of power outages
- **Increasing costs to businesses**, especially agricultural and goods movement sectors



To lessen the impacts on those that can least afford it, climate policies must be cost-effective, technology-neutral and most protective of the state's skilled and trained workforce. We





respectfully urge you to consider that selecting an unnecessarily high-cost pathway will deepen inequality for millions of Californians who are already feeling the squeeze of high energy costs.

California's climate policies have become more aggressive and more regressive, usually dictated by coastal affluent communities to the detriment of the rest of California's communities struggling to make ends meet. Our climate solutions should be available to all Californians, not just those that can afford electric vehicles, new appliances, and rooftop solar power.

There is no question that the climate crisis is real. We are all committed to being a part of the solution for a lower carbon future.

We believe you can create holistic climate strategies that consider the needs of every community, especially those most vulnerable to high costs, foster innovation, create jobs, and rebuild California's dwindling middle class. We can show the other states and nations that California can lead the way, without leaving anyone behind.

Getting it right will take courage from policy makers and regulators to think creatively, make adjustments, and stand up against costly and harmful policies.

As business and community leaders, we stand ready to work with this Board to adopt and implement an energy policy for our state that embraces carbon removal and other technologies to meet our emissions goals without forcing us to rely on a single technology that our electricity grid and infrastructure is ill-prepared for. For the sake of every Californian, and as an example to the Nation, we must get it right.

Sincerely,

African American Farmers of California, Will Scott Jr., President

Agricultural Energy Consumers Association, Michael Boccadoro, Executive Director

Californians for Affordable and Reliable Energy (CARE Coalition), Rob Lapsley, Chair

California Alliance of Small Business Associations, William R. La Marr, Executive Director,

California Asian Chamber of Commerce, David Nelson, VP of Public Policy

California Business Roundtable, Rob Lapsley, President & CEO

California Farm Bureau, Jim Houston, Administrator

California Fresh Fruit Association, Ian LeMay, President

California Fuels and Convenience Alliance, Samuel Bayless, Director of Policy

California Hispanic Chamber of Commerce, Julian Canéte, President

California League of Food Producers, Trudi Hughes, President & CEO

California Manufacturers and Technology Association, Lance Hastings, President & CEO
Central Valley Business Federation, Clint Olivier, CEO
Central Valley Latino Mayors and Elected Officials, Victor Lopez, Chair
Central Valley Yemen Foundation, Ali Ahmed, Co-Chair
Coastal Energy Alliance, Chris Collier, Founder & President
Fresno Farm Bureau, Ryan Jacobsen, CEO
Hispanic Chamber of Commerce San Francisco, Carlos Solórzano, CEO
Inland Empire Economic Partnership, Paul Granillo, President & CEO
International Warehouse Logistics Association, Mike Williams, Executive Director
Kings County Farm Bureau, Dusty Ference, Executive Director
Los Angeles Business Federation, Tracy Hernandez, Founder & CEO
Latin Business Association, Ruben Guerra, Chief Executive
Milk Producers Council, Kevin Abernathy, General Manager
Nisei Farmers League, Manuel Cunha Jr., President
Pro Small Biz CA, Jack Frost, President
Raisin Bargaining Association, Harvey Singh, Chairman
Small Business California, Scott Hauge, President, and Founder
Si Se Puede Foundation, Doug Kessler, Executive Director
Torrance Chamber of Commerce, Donna Duperron, President & CEO
Tulare County Farm Bureau, Tricia Stever Blattler, Executive Director



California Air Resources Board

Improved Program Measurement Would Help
California Work More Strategically to Meet Its
Climate Change Goals

February 2021

REPORT 2020-114





CALIFORNIA STATE AUDITOR

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Elaine M. Howle *State Auditor*



February 23, 2021

2020-114

The Governor of California
President pro Tempore of the Senate
Speaker of the Assembly
State Capitol
Sacramento, California 95814

Dear Governor and Legislative Leaders:

As directed by the Joint Legislative Audit Committee, my office conducted an audit of the California Air Resources Board (CARB). Our assessment focused on transportation programs intended to reduce greenhouse gas (GHG) emissions, and the following report details the audit's findings and conclusions. In general, we determined that CARB must do more to help the State work strategically toward its climate change goals.

CARB has not done enough to measure the GHG emissions reductions its individual transportation programs achieve. Specifically, CARB has not collected or evaluated sufficient data to allow it to determine whether or how its incentive programs, which pay consumers in exchange for purchasing low- and zero-emission vehicles, reduce GHG emissions beyond what CARB's regulations already require. For example, CARB has done little to measure the extent to which its incentive programs lead to emissions reductions by causing individuals and businesses to acquire clean vehicles that they otherwise would not. As a result, CARB has overstated the GHG emissions reductions its incentive programs have achieved, although it is unclear by how much. Given the ambitious nature of the State's climate change goals and the short time frame to meet them, California is in need of more reliable tools with which to make funding decisions.

Additionally, CARB has not consistently collected or analyzed data to determine whether some of its programs provide the socioeconomic benefits that CARB has identified for those programs, such as maximizing participants' economic opportunities. Because these programs may cost significantly more than other incentive programs from the perspective of reducing GHG emissions, CARB must do more to measure and demonstrate specific benefits to disadvantaged communities and low-income communities and households that the programs intend to serve. Finally, despite requirements in state law and its own guidelines, CARB has been slow to measure the jobs its programs create and support—or the benefits of the specialized job training that certain programs are supposed to provide. As with the need to assess accurately programs' GHG reductions, knowing whether its programs are achieving the expected important but more expensive socioeconomic benefits is crucial to providing the State with the information it needs to allocate its limited resources effectively in pursuit of its various goals.

Respectfully submitted,

A handwritten signature in black ink that reads "Elaine M. Howle".

ELAINE M. HOWLE, CPA
California State Auditor

Selected Abbreviations Used in This Report

CARB	California Air Resources Board
CalEPA	California Environmental Protection Agency
LAO	Legislative Analyst's Office
cap-and-trade fund	Greenhouse Gas Reduction Fund
UC Berkeley	University of California, Berkeley

Contents

Summary	1
Introduction	7
Chapter 1	
CARB Has Not Done Enough to Collect and Analyze Data to Demonstrate Its Programs' Effectiveness in Reducing GHG Emissions	19
Recommendations	38
Chapter 2	
CARB Has Not Adequately Demonstrated Its Programs' Socioeconomic Benefits	41
Recommendations	53
Other Areas We Reviewed	55
Appendix A	
CARB's Transportation GHG Emissions Reduction Programs	57
Appendix B	
Scope and Methodology	61
Response to the Audit	
California Air Resources Board	65
California State Auditor's Comments on the Response From the California Air Resources Board	73

vi | California State Auditor Report 2020-114
February 2021

Summary

Results in Brief

Fighting climate change is a key public policy concern for California. The State has set ambitious goals for reducing greenhouse gas (GHG) emissions—the primary source of air pollution linked to climate change—over the next decade and beyond. At the forefront of those efforts is the California Air Resources Board (CARB), which state law has given responsibility for controlling emissions from motor vehicles and for designing programs to reduce statewide GHG emissions.

However, California may not successfully meet its upcoming GHG reduction goal, which will require the State to reduce GHG emissions by nearly 40 percent over the next decade. Although other sources of GHG emissions have been declining in recent years, emissions from transportation have increased since 2013, and GHG emissions from transportation accounted for 40 percent of all statewide emissions in 2018. To help CARB fight climate change by reducing GHG emissions, the Legislature has allocated more than \$2 billion from the State’s Greenhouse Gas Reduction Fund (cap-and-trade fund) to CARB’s transportation programs since fiscal year 2013–14.

The State’s cap-and-trade program—one of the key elements of its climate change strategy—raises revenue by setting statewide limits on GHG emissions from major sources. The program allows the entities responsible for those sources to comply with the set limits by reducing their emissions or by paying the State for allowances to emit GHGs. The payments take place during quarterly auctions of GHG allowances, which have generated billions of dollars in annual revenue that the State then deposits in the cap-and-trade fund. Although it is substantial, cap-and-trade revenue is finite and can be unpredictable. Partly as a result of the ongoing COVID-19 pandemic, the cap-and-trade auction in May 2020 generated quarterly proceeds of only \$25 million—compared to an average of more than \$700 million for each of the previous 11 quarters. This drop in revenue caused a funding reduction of \$81 million to CARB’s programs for the year. Although the auction has rebounded somewhat since then, proceeds remain below the historical average. This uncertainty, together with the short time frame remaining before the 2030 date for achieving the State’s GHG goals, increases the challenge of meeting those GHG goals.

In *California’s 2017 Climate Change Scoping Plan*, CARB set forth key objectives for reducing GHGs from California’s various transportation sectors, including passenger vehicles, heavy-duty trucks, buses, and freight. To achieve its objectives, CARB has

Audit Highlights . . .

Our audit of CARB’s transportation programs for reducing GHG emissions highlighted the following:

» *CARB has not done enough to measure the GHG emissions reductions its incentive programs achieve.*

- *It does not account for overlap of its incentive programs and regulatory programs.*

- *It has generally not determined the effects its incentive programs have on consumers’ behavior and thus, has overstated GHG emissions reductions its incentive programs achieve.*

» *Although cap-and-trade revenue is substantial, it is finite and can be unpredictable—it experienced a significant drop in 2020.*

» *Although CARB is required to use cap-and-trade funds in a way that maximizes economic benefits and fosters job creation, it has done relatively little to measure specific socioeconomic benefits.*

- *It has been slow to measure the jobs its programs create or support and the benefits of job training its programs require.*

designed and implemented a range of programs targeted at reducing GHG emissions from specific vehicle types. Many of CARB's programs fall into two general categories: regulatory programs and incentive programs. CARB establishes its regulatory programs through a formal public rulemaking process, and some of these programs require vehicle manufacturers to produce and sell certain types of vehicles or for their vehicles to meet GHG emissions standards. Incentive programs are voluntary programs that often provide monetary payments to consumers who purchase low- and zero-emission vehicles. CARB implements these programs—sometimes at the direction of the Legislature—and reviews the programs' funding each year.

Although they are different in how CARB operates them, regulatory and incentive programs may work toward the same objective. For example, CARB operates a regulatory program aimed at increasing the manufacture and sale of zero-emission passenger vehicles (ZEVs). The regulation underlying the program requires that auto manufacturers sell enough ZEVs each year to make up a required proportion of their overall sales. CARB also operates incentive programs that provide rebates or other financial support to consumers who purchase ZEVs. The intent of these rebates is to encourage customers to purchase ZEVs, which tend to be more expensive than gasoline-powered vehicles. All of these programs work simultaneously toward achieving CARB's objective of putting five million ZEVs on California roads by 2030. Given the ambitious nature of the State's GHG goals, it may be reasonable for CARB to operate multiple programs that work toward a shared transportation objective. However, to ensure that it is operating the most effective mix of programs to achieve the State's goals, it is important for CARB to identify the GHG reductions that each individual program achieves.

Our review determined that although CARB generally approaches the projected GHG reductions from its individual programs in a reasonable way, it has not accounted for overlap between some of its programs. For the eight regulatory programs we reviewed, we found that when proposing the new regulation, CARB generally identified the relationship between the regulation and other existing regulatory programs in order to isolate the expected additional GHG reductions. However, the proposed regulations did not assess how the regulatory programs might overlap with its incentive programs that work toward the same objective. Because CARB does not know whether funds for incentives will be available in the future to help manufacturers and consumers offset vehicle costs, CARB designs certain regulatory programs to achieve their GHG reductions without assistance from the incentive programs. Although reasonable, this approach means that the GHG

reductions it claims from its incentive programs should be over and above what the regulatory programs achieve, and CARB must be able to measure those additional GHG reductions.

However, CARB has not done enough to measure the emissions reductions its incentive programs achieve in their own right. CARB generally does not formally acknowledge the potential overlap with regulatory programs or discuss how it accounts for that overlap in its incentive programs' designs. In addition, CARB does not collect and measure data for passenger and heavy-duty vehicles in a way that allows it to assess the extent to which clean vehicle manufacturing and sales—and therefore GHG reductions—exceed the reductions that its regulatory programs require. If it did, CARB might be able to assess its incentive programs' GHG reductions based on any extra reductions that have occurred. For example, manufacturers are currently exceeding requirements in a regulatory program that requires them to sell ZEVs, raising the possibility that CARB's incentive programs are augmenting the regulatory program's impact. However, CARB does not know precisely how many additional ZEVs are being sold or how that number compares to the number of vehicles its incentive programs help pay for.

CARB also has generally not determined the effects its incentive programs have on consumers' behavior. Specifically, it generally does not know how often many of its incentive payments influence consumers to purchase a cleaner (lower-emission) vehicle than they otherwise would have purchased. Having this information is crucial to making accurate calculations of the GHG reductions of those programs because it would indicate whether the incentive *caused* the vehicle purchase and therefore produced the reductions. However, of the five incentive programs we reviewed where CARB provides a payment or other financial assistance to purchase a cleaner vehicle, CARB collects information about behavioral changes for only one: its Clean Vehicle Rebate Program. Even for that program, CARB has made only limited use of the behavioral data it collects. Finally, CARB may be missing opportunities to use other sources of data, such as federal tax credits for clean vehicles, to learn more about how effective its programs are in changing behavior. Although such analyses may be challenging, they may allow CARB to modify programs to increase their cost-effectiveness and to have a greater impact on emissions reductions.

CARB's inability to measure the GHG reductions from its cap-and-trade-funded incentive programs diminishes the usefulness of its annual reports to the Legislature on the GHG reductions from these programs. CARB's current reporting assumes that the emissions reductions from all of the vehicles funded by an incentive program would not otherwise occur. By not taking into account the effects that regulations and other factors have on emissions, CARB

overstates the incentive programs' GHG reductions, although it is unclear by how much. One effect of this overstatement is to obscure the programs' cost-effectiveness in reducing GHG emissions. Without accurate information in the annual reports—which would make these reports a reliable emissions measurement tool—the Legislature's ability to make decisions about investments towards the State's GHG goals may be hampered. Specifically, if the annual reports contained accurate information, these reports could better help the Legislature make decisions about whether to continue funding a given program at its current level, decrease the funding and use those resources elsewhere, or significantly increase funding. Further, improved and clear metrics will help CARB to know when its incentive programs have successfully achieved their goals of helping low- and zero-emission vehicle technology become sustainable. As part of strengthening its program measurement overall, CARB must also do more to ensure that the data it collects on those programs are accurate and that the calculations CARB makes from the data are free of errors that can further distort the emissions reductions it reports.

State law directs CARB, to the extent feasible, to use cap-and-trade funds in a way that maximizes economic benefits and fosters job creation. More specifically, state law requires CARB to establish programs that increase access and provide benefits to Californians living in environmentally disadvantaged communities as well as low- and moderate-income communities. In part, those requirements specify that minimum proportions of cap-and-trade spending must go to geographically defined disadvantaged and low-income communities.

Although CARB has exceeded these minimum spending requirements in recent years, it has done relatively little to measure the specific socioeconomic benefits of its programs. Some programs that CARB operates focus primarily on producing socioeconomic benefits, as opposed to maximizing GHG reductions. These programs may cost significantly more than other incentive programs because they offer higher incentive payments per vehicle and may require more administrative effort. Partly due to these additional costs, we expected CARB to demonstrate the programs' value by clearly defining and measuring the specific socioeconomic benefits.

Although CARB has identified benefits that include maximizing economic opportunities for participants, increasing participants' credit scores, and lowering their driving costs, it does not consistently collect data to determine whether the programs actually provide those benefits. For example, CARB collects information related to the auto loans in its Financing Assistance for Lower-Income Consumers program, but it has not collected

information to measure whether participants' credit scores increased or if they subsequently qualified for housing loans. CARB did make an effort to design participant surveys for a separate program—Clean Cars 4 All—that asked specific questions about changes to participants' employment opportunities or income. However, even though the surveys could help CARB determine whether the program is providing the intended socioeconomic benefits, CARB does not require the entities that administer the day-to-day operations of the programs to use those specific survey questions, and it does not know whether they do so. CARB has also missed opportunities to use data it has already collected to determine whether participants receive the intended benefits of its programs.

Finally, CARB has been slow to measure the jobs its programs create or support, and it has done little to measure the benefits of the job-training activities that its own guidelines require. Despite requirements since 2015 in both state law and CARB's own funding guidelines that cap-and-trade programs must encourage job creation, CARB only began formally collecting information related to jobs in 2019. Further, at the time of our review, it had collected this information in its reporting database for just three of the nine programs we reviewed for which it should have done so. Additionally, despite clear language in its funding guidelines that programs should also support on-the-job training and requirements for reporting the outcomes of that training, CARB has not always collected detailed information about such training or its participants. As with the need to accurately assess programs' GHG reductions, knowing whether these important but more expensive socioeconomic benefits are occurring is crucial to providing the State with the information it needs to allocate its limited resources effectively.

Summary of Recommendations

To improve its ability to isolate each of its incentive programs' GHG reductions, by February 2022 CARB should establish a process to formally identify its incentive programs' overlap with other programs that share the same objectives.

To improve its ability to identify the effectiveness of each of its incentive programs in reducing GHG emissions, by August 2021 CARB should develop a process to define, collect, and evaluate data on the behavioral changes that result from each of its incentive programs.

To better assist the State in achieving its GHG goals, CARB should use the information we describe above to refine its GHG emissions estimates for its incentive programs in its annual reports to the Legislature, the funding plans approved by its board, and any longer-term planning documents or reports.

To better demonstrate that its incentive programs are as effective as possible in achieving specific socioeconomic benefits, by February 2022 CARB should develop a process to define, collect, and evaluate data that will translate to metrics showing the socioeconomic benefits that result from each of the incentive programs.

To provide transparency to the Legislature and other stakeholders, beginning in 2022 and using the metrics and data described above, CARB should make funding and design recommendations in its funding plans and annual reports based on which programs are effective in producing socioeconomic benefits and at what cost.

Agency Comments

CARB agreed with our recommendations and indicated that it is taking steps to implement them.

Introduction

Background

The California Air Resources Board (CARB) is the state agency charged with combating air pollution and regulating sources of greenhouse gas (GHG) emissions in order to mitigate the adverse impacts of climate change.¹ State law gives CARB responsibility for controlling emissions from motor vehicles and requires CARB to coordinate efforts related to attaining and maintaining air quality standards. As part of its responsibilities, CARB is required to design emissions reduction measures and to monitor and regulate sources of GHG emissions in order to reduce them.

Serious and escalating problems in California have been linked to climate change, including wildfires, water shortages, threats to agriculture, and health threats from air pollution. California's *Fourth Climate Change Assessment* report from 2018, the most recent such assessment, explains that temperatures are warming and that available science indicates that many people will endure more illness and be at greater risk of early death in California because of climate change. Accordingly, climate change is a major and time-sensitive public policy concern, and one for which the State has established specific goals. In 2005 Governor Schwarzenegger issued an executive order that described the need to reduce GHG emissions and established emissions reduction targets. As part of the California Global Warming Solutions Act of 2006, a landmark California law that established the State's GHG reduction program, the Legislature declared that global warming—an aspect of climate change—poses a serious threat to the economic well-being, public health, natural resources, and environment of California. The Legislature also identified California as a national and international leader in environmental stewardship efforts and stated that California's GHG reduction program would place it at the forefront of national and international efforts to reduce GHG emissions.

Over the past 15 years, California has enacted certain laws and executive orders intended to reduce GHG emissions. Two of these enactments specifically require CARB to ensure that California reduces its GHG emissions to certain levels by specified dates. For example, the California Global Warming Solutions Act of 2006 required CARB to adopt a statewide GHG emissions

¹ Global warming is the long-term heating of Earth's climate generally attributed to human activities, primarily the burning of fossil fuels. Climate change encompasses global warming, but it also refers to the broader range of changes happening to the planet as a consequence of global warming. We use the term "climate change" in the report instead of "global warming" because it encompasses the broad consequences of human activities on the climate.

limit equivalent to the State’s 1990 emissions level and to design reduction measures that would enable the State to meet that limit by 2020. In 2007 CARB established the 2020 limit at 427 million metric tons (MMT) of GHG emissions per year, and it later increased that limit to 431 MMT. Similarly, in April 2015, Governor Brown issued an executive order to establish a goal of reducing GHG emissions to 40 percent below 1990 levels by 2030, and the Governor’s Office described the goal as the most aggressive benchmark enacted by any government in North America. The Legislature subsequently passed legislation in 2016 requiring CARB to ensure that California meets that goal, which means achieving GHG levels of 260 MMT by 2030. Other relevant laws and executive orders include those aimed at supporting the development and deployment of low-emission heavy-duty trucks and increasing the volume of zero-emission vehicles (ZEVs) sold in the State. For example, in a September 2020 executive order, Governor Newsom directed CARB to adopt new regulations to increase ZEV sales with the goal that by 2035 all new passenger cars and trucks sold in California will be ZEVs. The Governor subsequently proposed allocating \$1.5 billion in special funding as part of the State’s fiscal year 2021–22 budget in order to help implement the State’s ZEV objectives.

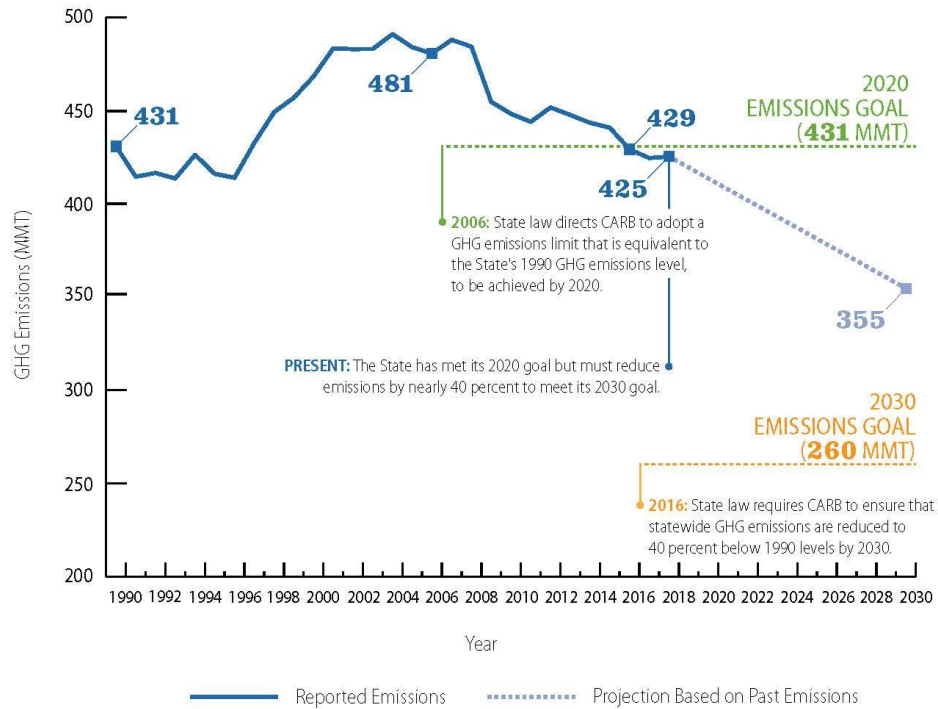
	2013 (MMT)	2018 (MMT)
Transportation	161	169
All other sources	286	256
TOTAL	447	425

Source: CARB’s 2020 GHG emissions report.

However, California may not meet its goal of reducing GHG emissions to 260 MMT per year by 2030. According to CARB’s report *California Greenhouse Gas Emissions for 2000 to 2018*, published in 2020 (2020 GHG emissions report), in 2018 California’s emissions were 425 MMT, meaning that although it has achieved the 2020 goal of 431 MMT, the State still needs to reduce annual emissions by nearly 40 percent over the next decade to reach the 2030 goal. The text box shows that, although other sources of GHG emissions have declined in recent years, transportation-related emissions

have increased slightly, leading to a problematic trend. In 2013 transportation-related emissions were responsible for 36 percent of California’s total GHG emissions; as of 2018, they accounted for 40 percent of the total. Figure 1 shows the evolution of California’s GHG emissions goals and the trend in GHG emissions since 1990. As the Figure demonstrates, the State will fall short of meeting the 2030 goal unless emissions reductions occur at a faster pace.

Figure 1
California Has Implemented Goals to Reduce GHG Emissions



Source: CARB's GHG emissions reports, *California's 2017 Climate Change Scoping Plan*, state law, CARB Resolution 14-16, and our projections of future GHG emissions based on the average annual change in GHG emissions over the past 10 years.

According to CARB's 2020 GHG emissions report, the other 60 percent of California's GHG emissions come from sources such as industrial operations and electric power generation. The vast majority of California's GHG emissions reductions since it established the statewide emissions limits in 2006 have come from electric power generation. CARB has acknowledged the need for greater contributions from the transportation sector in order to meet the 2030 GHG emissions reduction goals.

CARB's 2020 GHG emissions report also shows that within the transportation sector, two categories of vehicles accounted for more than a third of California's total emissions in 2018. Passenger vehicles, which include cars and small trucks driven on California's roads, account for 70 percent of transportation emissions and more

than 28 percent of the State’s total emissions. The second-highest level of emissions comes from heavy-duty vehicles, that is, large trucks and buses, which account for 20 percent of transportation emissions and 8 percent of total state emissions. Other smaller transportation categories include aviation, rail, and ships, which combined generally account for the rest of California’s transportation emissions.

One of the key elements of California’s strategy to reduce GHG emissions is a statewide cap-and-trade program that sets a cap on statewide GHG emissions and provides funding for CARB’s programs. The cap-and-trade program effectively sets a statewide limit on GHG emissions from major sources, such as electricity generation, and allows the entities responsible for those sources to meet the limit by reducing their emissions or by paying for allowances to emit GHGs. The payments take place during quarterly auctions, which have generated billions of dollars in revenue. The State deposits the revenue in its Greenhouse Gas Reduction Fund (cap-and-trade fund). State law allocates cap-and-trade revenue to various state agencies, including CARB, for the purpose of supporting programs intended to further reduce GHG emissions.

CARB’s Transportation Programs

CARB has established objectives to reduce transportation-related GHG emissions to meet the State’s overall emissions goals. To meet those goals, CARB designs, implements, and oversees a variety of programs. State law requires CARB to prepare a scoping plan for achieving the maximum technologically feasible and cost-effective GHG reductions and to update that plan at least every five years. In its 2017 scoping plan, CARB published a set of objectives for achieving California’s GHG goals. The text box summarizes CARB’s key objectives for reducing transportation emissions in California, as outlined in that plan.

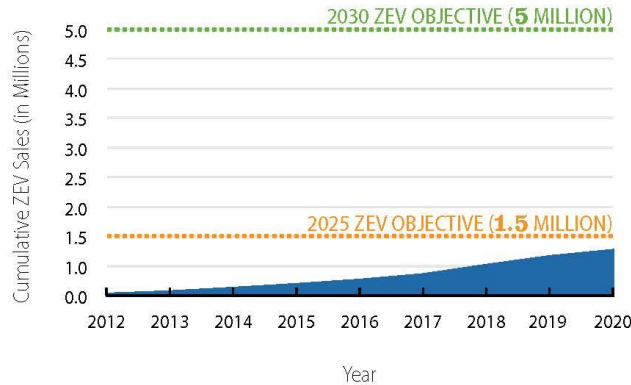
As the text box shows, putting millions of ZEVs on California roads is part of California’s plan to reach its GHG emissions reduction goals. These ZEV objectives were established through executive orders from Governor Brown. Figure 2 shows that as of October 2020, more than 700,000 ZEVs have been sold in California, but the market still needs to grow significantly for the State to meet its objectives.

CARB’s Key Objectives for California’s Transportation Sector

- Transition to ZEVs, including 1.5 million ZEVs by 2025 and 5 million ZEVs by 2030.
- Adopt more stringent GHG emissions requirements for all light-duty vehicles, including passenger vehicles.
- Reduce GHG emissions from medium- and heavy-duty vehicles.
- Transition to clean transit (bus) options.
- Reduce vehicle miles traveled by passenger vehicles.
- Improve freight system efficiency and deploy freight vehicles and equipment capable of zero or near-zero emissions.
- Transition to cleaner fuels that emit lower amounts of GHGs.

Source: CARB’s 2017 scoping plan and Governor’s executive orders.

Figure 2
California's ZEV Sales Must Continue to Increase to Meet Long-Term Objectives



Source: Executive orders and analysis of market data on light-duty ZEV sales from the California Energy Commission.

Note: 2020 sales here are as of the end of October 2020.

To help California achieve the ZEV objective, CARB operates multiple programs aimed at increasing ZEV ownership and supporting the ZEV market. The programs CARB has implemented in this area fall into two general categories: regulatory programs and incentive programs. CARB establishes its regulatory programs through a formal public rulemaking process; some of these programs require vehicle manufacturers to produce and sell certain numbers and types of vehicles or meet GHG emissions standards. For example, CARB operates a regulatory program aimed at increasing ZEV ownership that requires certain auto manufacturers to sell enough ZEVs to make up a required proportion of their overall sales in the State. These ZEVs include full battery-electric, hydrogen-fueled electric, and plug-in hybrid electric vehicles.

Incentive programs are voluntary programs that often provide monetary payments to consumers who purchase low- and zero-emission vehicles. CARB approves these programs—sometimes at the direction of the Legislature—and reviews the programs’ funding each year. For example, CARB operates incentive programs that provide rebates or other financial support to consumers who purchase ZEVs. The intent of these rebates is to encourage customers to purchase ZEVs, which tend to have a higher sales price than gasoline-powered vehicles. The largest of these programs is the Clean Vehicle Rebate Project (CVRP), which has received more than \$940 million from the cap-and-trade fund.

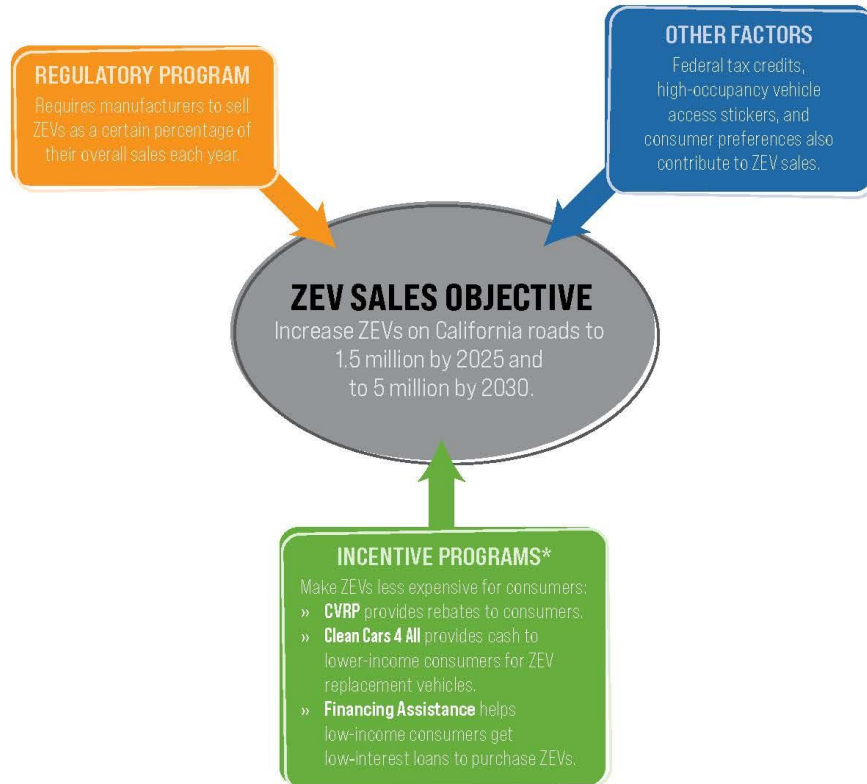
CVRP is a statewide program that allows consumers to apply for rebates if they purchase battery-electric vehicles, hydrogen-fueled electric vehicles, plug-in hybrid electric light-duty vehicles, or zero-emission motorcycles. The maximum rebate amounts range from \$750 to \$7,000, depending on the type of vehicle purchased and the consumer's income level.

All of these programs work simultaneously toward achieving increasing ZEV sales. As Figure 3 illustrates, other factors like consumer preference and outside programs also play a role. Therefore, when a consumer buys a new ZEV in California, any combination of these factors may contribute to the consumer's decision. The regulatory programs cause manufacturers to produce and sell the vehicles, while incentive programs, along with other factors, influence the consumers' purchasing decisions. Further, some incentive programs overlap with one another, and consumers may use multiple incentives when purchasing a single vehicle. CARB's programs do not operate in a vacuum; they can directly target the same objectives or even the same vehicles.

CARB also operates regulatory and incentive programs that work toward shared objectives in other transportation areas. For example, CARB operates regulatory programs that require manufacturers to produce lower-emission heavy-duty vehicles, such as trucks. In one of these programs, manufacturers can earn compliance credits based on the lowered emissions from their heavy-duty vehicles. CARB simultaneously operates the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), which provides vouchers to commercial vehicle users, such as school districts, small businesses, and transit agencies, to help them purchase low- and zero-emission trucks and buses. Additionally, manufacturers can receive a higher number of compliance credits for producing HVIP-eligible trucks than they do for producing standard trucks. Both programs work toward the objective of reducing GHG emissions from heavy-duty vehicles.

CARB also has certain *pilot programs*, which receive lower amounts of funding and are generally smaller in scope than larger programs like CVRP and HVIP. For example, CARB's bus pilot program provides funding for local transportation agencies to acquire small numbers of zero-emission buses in order to reduce GHG emissions and demonstrate the practicality and viability of widespread adoption of that technology. During this audit, as Table A in Appendix A shows, we reviewed eight regulatory programs and 10 incentive programs operated by CARB, as well as one program—the Sustainable Communities program—intended to help the State reach its 2030 goals by reducing vehicle miles traveled and therefore GHG emissions for which CARB provides some oversight. CARB operates all 10 of the incentive programs we reviewed through program administrators who manage the day-to-day operations of the programs. In some cases, these program administrators are private nonprofit organizations; in others, they are local air districts. CARB oversees the programs through grant agreements that lay out specific program requirements and it is responsible for ensuring the success of these programs.

Figure 3
Various Factors Simultaneously Contribute to Increased ZEV Sales



Source: Analysis of CARB's regulatory and incentive programs, other state programs, federal programs, and executive orders.

* Consumers may receive multiple incentives in order to purchase a single vehicle.

Measuring Programs' GHG Reduction-Related Benefits

Given the ambitious nature of the State's goals for GHG emissions reductions and the progress still needed to meet those goals, it may be reasonable to have multiple programs that work together to address a shared transportation objective—such as putting more zero-emission cars on California's roads or reducing GHG emissions from heavy-duty vehicles. However, a 2018 report by the Legislative Analyst's Office (LAO) concluded that operating multiple programs with shared objectives can make it difficult to evaluate the effects of each program. The report notes that there is a

wide range of state and federal emissions programs that can overlap, including regulatory and incentive programs aimed at increasing the sale of ZEVs, as we discuss above. The report concludes that the interaction between the various programs can make it difficult to evaluate the effects of each program. For example, although ZEV sales in California are increasing, the regulatory and incentive programs' shared objective can make it difficult to know how many cars are sold because of the regulation and how many because of the incentives. The LAO's report stated that this limitation may, in turn, make it difficult for the State to determine which programs the State should expand to achieve future goals most effectively.

The LAO report also described *free-riders*—consumers who receive a vehicle rebate for purchasing a ZEV but would have purchased the vehicle even without the rebate. For example, such a consumer may already believe that the savings from reduced fuel costs outweigh the additional upfront costs to purchase a ZEV. Further, some consumers' primary motivation for buying a ZEV may be the desire to drive a cleaner vehicle or they may be less likely to depend on a rebate for their purchase decisions because they have higher incomes. According to the LAO's report, failure to account for these consumers could result in overstated estimates of direct emissions reductions for some programs. In fact, research indicates that it is important to measure behavioral responses to economic incentives such as rebates in order to determine their effectiveness.

Benefits Not Related to GHGs

In addition to reducing GHG emissions, CARB designs and operates programs intended to achieve socioeconomic benefits. State law directs a minimum percentage of cap-and-trade funding to two populations—*disadvantaged communities* and *low-income communities or households*. State law tasks the California Environmental Protection Agency (CalEPA) with identifying disadvantaged communities in California. CalEPA has classified these communities based on their sensitivity to environmental pollution using a range of factors, including air pollution and public health data. State law defines low-income communities as those areas in which median household income falls below certain statewide thresholds. State law requires that a minimum of 25 percent of cap-and-trade funding be allocated to projects located in disadvantaged communities and a minimum of 10 percent to low-income communities or households.

State law also directs CARB to design programs that achieve other benefits beyond GHG emissions reductions and minimum required spending. For example, state law directs CARB to use cap-and-trade

funds in a way that maximizes economic benefits and that fosters job creation by promoting in-state GHG emissions reduction projects carried out by California workers and businesses. In addition, the Legislature has directed CARB to establish programs that are accessible to and provide benefits for Californians living in disadvantaged, low-income, and moderate-income communities, including increasing their access to affordable ZEVs and near-zero-emission vehicles. CARB's own funding guidelines state that agencies that receive cap-and-trade funding must, to the extent feasible, foster job creation and training with an emphasis on disadvantaged and low-income communities and households.

To achieve socioeconomic benefits, including reduced transportation costs, some of CARB's programs focus on achieving equitable outcomes instead of maximizing GHG emissions reductions. For example, its Financing Assistance for Lower-Income Consumers program (Financing Assistance program) provides low-income consumers with grants and low-interest loans to purchase ZEVs or hybrid vehicles that the consumers otherwise might not be able to afford. CARB states that it also expects the program to provide economic benefits for its participants, including increased credit scores and the ability to qualify for housing loans, presumably because of their improved credit. Similarly, CARB operates an Agricultural Worker Vanpools program that provides agricultural workers in disadvantaged and low-income communities with transportation to their worksites in low-emission vans, in place of those workers using their individual gasoline-powered vehicles or vanpooling in gasoline-powered vans.

Because these programs are less cost-effective in achieving emissions reductions, it is critical for CARB to measure other benefits and make funding decisions accordingly. For example, the Financing Assistance program spends seven times more to reduce GHG emissions by one metric ton than the CVRP program does. Therefore, CARB must clearly define and measure the specific benefits—other than GHG emissions reductions—that it intends programs like Financing Assistance to achieve.

Reporting and Resources

CARB's board approves an annual funding plan that describes the goals and expected benefits for many of its cap-and-trade-funded incentive programs. The funding plan covers incentive programs, including CVRP, HVIP, and Financing Assistance, and in it CARB annually updates its board on the status of its programs. The updates include summaries of the activities performed to date and overviews of the purposes of the programs. CARB then

Total Cap-and-Trade Funds Allocated by CARB to the Transportation Incentive Programs We Reviewed

- CVRP (\$944 million)
- HVIP (\$488 million)
- Funding Agricultural Replacement Measures for Emission Reductions (FARMER) (\$251 million)
- Advanced Technology Demonstration Projects (\$230 million)
- Clean Cars 4 All (\$102 million)
- Zero-emission bus pilot program (\$85 million)
- Car-sharing pilot program (\$55 million)
- Zero-Emission Drayage Truck pilot program (\$40 million)
- Financing Assistance program (\$34 million)
- Agricultural Worker Vanpools (\$6 million)

Source: CARB's 2020 annual report to the Legislature, fiscal year 2020–21 funding plan, expenditure records, and our program review.

Note: The zero-emission bus pilot program's funding amount includes zero-emission truck pilot funding.

proposes funding allocations for each program. In fiscal year 2019–20, the Legislature allocated \$485 million in cap-and-trade funding for CARB's transportation programs, bringing the total allocation to more than \$2 billion in cap-and-trade funding since fiscal year 2013–14. The text box lists the total cap-and-trade funds CARB allocated to the incentive programs we reviewed for fiscal years 2013–14 through 2019–20. CARB also uses the funding plan to propose new programs, and CARB staff stated that the funding plans contain the justification or design for most of the incentive programs we reviewed. The funding plan also projects the future GHG emissions reductions each program will achieve if given the requested level of funding. CARB bases its projections of GHG emissions reductions on the number and types of vehicles it expects the programs to support.

CARB also reports annually to the Legislature regarding the estimated benefits its cap-and-trade-funded programs have achieved.² The annual report covers programs administered by CARB as well as programs administered by other state agencies. State law requires CARB to develop funding guidelines for all agencies that receive cap-and-trade funding. The annual report contains

data on the estimated GHG reductions the majority of CARB's (and other agencies') programs achieved as well as the programs' cost. It is also the primary mechanism for CARB to inform the Legislature of the benefits of its programs for disadvantaged and low-income communities.

Limited and potentially unpredictable funding underscores the State's tight time frame for meeting the 2030 goal. CARB operates a range of programs aimed at reducing transportation GHG emissions, and many of these programs receive their funding from the State's cap-and-trade fund. As we note above, in fiscal year 2019–20, the Legislature appropriated \$485 million from the cap-and-trade fund to CARB's transportation programs. However, in part because of the ongoing COVID-19 pandemic, the quarterly cap-and-trade auction in May 2020 generated quarterly

² State law requires the Department of Finance (Finance) to submit an annual report to the Legislature on the status and outcomes of cap-and-trade funded programs. The law also requires CARB to develop funding guidelines for the agencies administering programs, and those guidelines state that CARB compiles data from the administering agencies and coordinates with Finance to prepare the report. Therefore, although Finance submits the report to the Legislature, because of CARB's lead role in preparing it, we refer to it as "CARB's annual report" at times in this report.

proceeds of only \$25 million, compared to the average of more than \$700 million that it had received for each of the previous 11 quarters. The May 2020 decrease caused a reduction in funding to CARB's programs for the year of \$81 million, from \$557 million to \$476 million. Although the auction revenue has rebounded somewhat since, with the last two auctions raising \$474 million and \$587 million, it remains below the historical average—compounding the State's short time frame as another challenge to meeting its GHG goals. This uncertainty also highlights the importance of CARB's ability to assess and maximize the effectiveness of its transportation programs as well as to help the Legislature guide the State's resources to programs that will best help California achieve its GHG reduction goals.

18 | California State Auditor Report 2020-114
February 2021

Chapter 1

CARB HAS NOT DONE ENOUGH TO COLLECT AND ANALYZE DATA TO DEMONSTRATE ITS PROGRAMS' EFFECTIVENESS IN REDUCING GHG EMISSIONS

Chapter Summary

The State is at risk of not meeting its GHG reduction goals for 2030, and CARB has acknowledged the need for greater emissions reductions from the transportation sector. Because transportation-related emissions are the largest single source of GHG emissions in California and because they have increased in recent years, it will be necessary to accelerate the pace of reduction if the State is to achieve its goals. Given the ambitious nature of these goals and the progress still needed to meet them, it may be reasonable for CARB to operate multiple programs that address a shared transportation objective. However, to ensure that it is operating the most effective mix of programs, it is important for CARB to identify the GHG reductions that each individual program achieves.

CARB does not formally account for the incentive programs' overlap with relevant regulatory programs, nor does it collect and analyze all of the data necessary to isolate the incentive programs' GHG emissions benefits. CARB has also not done enough to measure or collect data about behavioral changes of the participants in its consumer-focused incentive programs, further limiting its ability to identify the programs' individual impacts on emissions.

The State needs more accurate program measurement to guide its GHG investments and increase the chances of meeting its GHG goals. The measurement concerns we identified limit the usefulness of the information CARB reports annually to the Legislature about the GHG reductions from its cap-and-trade-funded incentive programs. Specifically, CARB overstates the programs' GHG reductions, although it is not clear by how much. These reporting issues also obscure the programs' true cost-effectiveness. Finally, CARB must do more to ensure that the emissions reductions it reports are accurate and supported by valid underlying data.

CARB Has Not Identified the GHG Reductions Its Incentive Programs Provide

CARB's regulatory and incentive programs are intended to work toward shared objectives for reducing GHGs, such as increasing the number of ZEVs on California's roads. CARB has taken steps

CARB's lack of measurement of participants' behavioral changes limits its ability to project the longer-term benefits of its incentive programs.

to identify the new GHG reductions its regulatory programs are intended to achieve and has generally designed those reductions to be achievable through the regulatory programs alone. However, it has not done enough to demonstrate the amount of GHG reductions it projects and measures for its incentive programs. CARB does not collect certain data or perform measurements that would help it determine those additional impacts, including the extent to which the incentive programs motivate consumers to purchase lower-emission vehicles that they otherwise would not have purchased. CARB's lack of measurement of participants' behavioral changes also limits its ability to project the longer-term benefits of its incentive programs.

CARB Cannot Distinguish the Individual GHG Benefits of Multiple Programs That Work Toward Shared Objectives

Given the ambitious nature of the State's goals for GHG reductions, it may be reasonable for CARB to operate multiple programs that work toward a shared transportation objective, such as putting more ZEVs on California's roads or reducing GHG emissions from heavy-duty vehicles. However, to ensure that it is operating the most effective mix of programs, it is important for CARB to identify the GHG reductions that each individual program achieves. The short time frame remaining for the State to meet its 2030 GHG goals also underscores the need for the best information possible to guide the use of the State's limited resources.

We engaged an environmental consultant to help us review CARB's methods for projecting the GHG emissions reductions it expects its programs to achieve. For the eight regulatory programs and nine of the incentive programs we reviewed, our consultant determined that CARB's methodologies for estimating emissions reductions were generally reasonable on a program-by-program basis.³ However, because of the potential overlap among many of these programs, we—along with our consultant—also evaluated whether CARB accounted for that overlap when designing the programs and when measuring the programs' actual estimated GHG reductions.

For the eight regulatory programs we reviewed, which CARB approved or modified between 2007 and 2020, CARB generally identified relevant overlap between those proposed regulatory programs and other existing transportation regulatory programs. For example, when it proposed a new regulatory program in 2018 to require transit agencies to purchase only zero-emission buses in the

³ The solicitation for one of our 10 selected incentive programs, the Zero-Emission Drayage Truck Pilot, was not released until late November 2020, and we therefore did not include it in our review of GHG emissions reductions.

future, CARB took steps to account for GHG reductions from the existing regulatory programs that set emissions requirements for buses. By doing so, CARB isolated the additional GHG emissions reductions that the new regulation would achieve.

In contrast, although the proposed regulatory programs sometimes acknowledged the existence of incentive programs that share the same objectives, CARB did not formally assess how relevant incentive programs might overlap with the proposed regulatory programs. When we asked CARB why it did not assess these overlaps, key staff and program managers for two regulatory programs explained that they did not consider incentive programs when determining the regulation's costs. Specifically, CARB does not assume that incentive funds will be available in the future to help manufacturers and consumers offset vehicle costs. Therefore, CARB designed these regulatory programs to achieve the expected reductions without help from incentive programs that target the same types of vehicles. Although reasonable, this approach means that any GHG reductions it claims from incentive programs that work toward the same objectives should be above and beyond what the regulatory programs achieve. Because incentive programs can represent significant costs, it is important that CARB be able to measure those additional GHG reductions to ensure that it is pursuing the most effective approaches to meeting the State's goals.

However, CARB has not done enough to measure the emissions reductions its incentive programs achieve beyond the reductions brought about by its regulatory programs. We reviewed documentation related to a selection of CARB's incentive programs and found that CARB generally did not acknowledge the potential overlap with regulatory programs or discuss how it accounted for the overlap in the incentive programs' design. CARB also does not measure precisely how many additional GHG benefits its incentive programs may actually provide. For example, as we discuss in the Introduction, CARB has a regulatory program that requires car manufacturers to sell ZEVs and it operates incentive programs that provide payments to consumers to encourage them to purchase ZEVs. According to CARB's 2019 *Zero Emission Vehicle Credits* report, released in August 2020, car manufacturers were overcomplying with the ZEV regulation. This overcompliance could indicate that CARB's ZEV incentive programs achieve additional GHG emissions reductions by driving consumer demand and ZEV sales beyond what would be sold under the regulation alone. However, CARB has not determined whether its incentive programs are responsible for the additional sales.

CARB offered two primary reasons for not performing such a determination, but these reasons suggest a lack of coordination in measuring how the respective programs perform. First, CARB does

CARB has not done enough to measure the emissions reductions its incentive programs achieve beyond the reductions brought about by its regulatory programs.

not track the number of ZEVs sold over and above the number required by the regulation because the regulatory program is not designed to measure or require reporting on the number of vehicles sold. Instead, the regulatory program uses a system in which manufacturers earn a certain number of credits per vehicle sold in California, and CARB monitors manufacturers' credit balances to ensure that they have complied with the regulation. In addition, some ZEVs earn more credits than others. For example, a vehicle with a 350-mile battery range earns the manufacturer four credits, while a vehicle with a 50-mile range earns only one credit. Although longer-range battery-electric vehicles do not have a greater direct impact on GHGs, because they may be more attractive to consumers, the regulatory program awards more credits for these vehicles to reward manufacturers for producing and selling them.

In contrast, CARB measures the GHG emissions reductions achieved by its incentive programs using the number of vehicles for which CARB provides a rebate. CARB staff explained that although it is feasible to report the credits generated in a year and the number of ZEVs sold, CARB has not done so because of the reporting requirements and how it evaluates compliance with the regulation. Because it has not taken steps to coordinate the performance measurements for regulatory and incentive programs, CARB does not know how the additional ZEVs being sold in the State compare to the number of rebates CARB provides through its incentive programs. Being able to make that comparison would be an important step in analyzing the extent to which CARB's incentive programs achieve additional emissions reductions.

Second, the manager for CVRP, the largest incentive program, stated that CARB cannot conclusively identify how many ZEVs are on the road because of CVRP, as many factors play a role in a consumer's decision to purchase one. The manager explained that if the market for ZEVs is increasing, CARB assumes that CVRP is having a positive impact on the market. However, without conducting analyses to validate these assumptions, CARB cannot accurately identify the GHG emissions reductions that its ZEV incentive programs are actually achieving.

Without conducting analyses to validate its assumptions, CARB cannot accurately identify the GHG emissions reductions that its ZEV incentive programs are actually achieving.

We identified similar gaps in CARB's analysis of how HVIP, an incentive program for low- and zero-emission trucks and buses, relates to CARB's regulatory program that establishes GHG emissions limits for heavy-duty trucks and buses. As it does in the ZEV regulatory program, CARB uses a credit system to monitor its regulation of GHG emissions for heavy-duty vehicles. Manufacturers can earn credits by producing low- or zero-emission heavy-duty vehicles, such as trucks and buses, and HVIP provides incentives to encourage companies and transit agencies to buy these vehicles. However, unlike their practice for the ZEV program,

staff do not track the total number of credits that all manufacturers have generated under the heavy-duty GHG regulatory program across the entire industry; instead, CARB explained that it assesses each manufacturer individually. The CARB branch chief who oversees compliance with this regulation explained that CARB has been focused on ensuring that individual manufacturers comply with the regulation but acknowledged that it would be possible to calculate the industrywide credit balance. Until it does, CARB does not know whether the industry as a whole has overcomplied with the requirements in a way that might indicate an additional effect from incentives.

Moreover, CARB has not evaluated the extent to which manufacturers are using HVIP-eligible vehicles to comply with the GHG regulations for heavy-duty vehicles. Without assessing the relationship between HVIP and the related regulatory program, CARB cannot demonstrate whether HVIP is achieving GHG reductions over and above what the regulatory program would achieve on its own. As with the ZEV programs, a greater level of coordination here is needed. In fact, the branch chief confirmed that CARB collects the data it needs to determine how frequently manufacturers have used vehicles eligible for incentives like HVIP to comply with regulatory requirements, but that the analysis would require coordination across different divisions of CARB.

CARB has also not isolated the GHG reduction benefits of incentive programs that overlap with one another. In addition to sharing the same transportation objective of increasing ZEVs in California, three of the incentive programs we reviewed—CVRP, Clean Cars 4 All, and Financing Assistance—also overlap because qualifying consumers are able to receive financial support from one, two, or all three programs for a single purchased vehicle. Therefore, if CARB does not account for this overlap, it could lead to the double or triple counting of emissions reductions associated with a single vehicle. Despite this risk, our consultant found that CARB’s methodologies for estimating the emissions reductions from the Clean Cars 4 All and CVRP programs do not account for the overlap or specify how CARB avoids simultaneously assigning the emissions reductions from a single vehicle to multiple programs. Because the Clean Cars 4 All and Financing Assistance programs are relatively small compared to CVRP and because not all consumers are eligible for incentives from multiple programs, the effect of the overlap on CARB’s emissions estimates may be relatively small. However, given that the Governor’s budget for fiscal year 2021–22 proposed directing increased funding to existing transportation programs such as Clean Cars 4 All and Financing Assistance, the importance of this measurement issue could significantly increase if CARB does not take steps to address it.

CARB has not isolated the GHG reduction benefits of incentive programs that overlap with one another, which could lead to the double or triple counting of emissions reductions associated with a single vehicle.

CARB Does Not Know How Frequently Its Incentive Programs Change Purchasing Behavior

Knowing the extent to which its incentive programs change participants' behavior is crucial for CARB to accurately assess the effectiveness of those programs in achieving additional GHG reductions. Research has shown that it is important to measure behavioral responses to economic incentives such as rebates in order to determine an incentive's effectiveness. For example, determining how frequently an incentive payment influences consumers to purchase a cleaner vehicle than they otherwise would choose is a way of accounting for individuals who would purchase cleaner vehicles anyway—sometimes called *free-riders*, as we discuss in the Introduction. CARB can then apply this information to its calculations of the vehicles' impacts on GHG emissions to determine the reductions for which the incentive program is responsible.

Conversely, failing to collect data on or measure behavioral effects could lead CARB to overstate the emissions reductions from its incentive programs. Such overstatement will occur if CARB gives an incentive program credit for the GHG reductions from all vehicles for which the program paid incentives, even if some consumers would have purchased some of those vehicles anyway. In such a scenario, the State would not be able to rely fully on the estimated GHG reductions reported for individual programs or on the relative cost-effectiveness of those reductions across programs. Problems with the reliability of this information would prevent CARB and the Legislature from being able to use it to direct the State's limited resources away from less effective programs and toward more effective ones.

Despite the importance of knowing whether incentive payments influence individuals' decisions, CARB has not done enough to measure or collect data about how its consumer-focused incentive programs have changed participants' behavior. As Table 1 shows, for five programs we reviewed in which CARB provides an incentive payment or other financial assistance to consumers who purchase a cleaner vehicle, CARB collects information about behavioral changes of participants for only one—CVRP. Specifically, CVRP participants who receive rebates are given a survey that asks whether they would have acquired their clean vehicle without the rebate. Two of the other programs have participant surveys that include questions about participants' satisfaction with their vehicles, among other topics. However, CARB was unable to adequately explain or provide documentation for its rationale as to why those surveys do not include questions about what led the participant to purchase the vehicle. For another program, the program manager stated that CARB does not have copies of the

CARB has not done enough to measure or collect data about how its consumer-focused incentive programs have changed participants' behavior.

survey questions that the external program administrators use; however, we found that the sample survey questions that CARB provides to the program administrators do not contain questions about whether participants would have purchased their vehicle without receiving an incentive. The CARB program manager for the last program—FARMER—could not remember why CARB does not require a survey of participants, but a program staff member noted that the air districts that help administer FARMER on CARB’s behalf stated that it was difficult to collect all of the required program information from participants and that the districts expressed hesitation to add more questions.

Table 1
CARB Rarely Collects or Uses Data on Participants’ Behavior for Key Incentive Programs

PROGRAM	IS THERE AN EXISTING SURVEY THAT COULD COLLECT PARTICIPANT BEHAVIORAL DATA?	IS DATA COLLECTED ABOUT PARTICIPANT BEHAVIORAL CHANGES?	HAS CARB USED THE DATA TO ADJUST THE PROGRAM?
Clean Cars 4 All	Yes	No*	No
CVRP	Yes	Yes	Yes
FARMER	No	No	No
Financing Assistance	Yes	No	No
HVIP	Yes	No	No

Source: CARB’s program grant agreements, surveys, survey data, fiscal year 2019–20 funding plan, and interviews with program managers.

* The program manager stated that CARB does not have copies of the survey questions that the grantees use; however, the sample survey questions that CARB provides to grantees do not contain questions about whether participants would have purchased their vehicle without participating in the program.

Program managers for the three incentive programs with surveys that do not collect behavioral change data expressed their belief that participants would not have purchased their vehicles without the incentives, but they could not demonstrate whether their belief is justified. For example, the manager for HVIP stated that there are not very many purchases of HVIP-eligible vehicles—zero- and low-emission trucks and buses—without an incentive and that HVIP-eligible vehicles represent a small part of the total market for heavy-duty vehicles. The manager’s claim suggests that HVIP is the reason consumers purchased the vehicles and that they would not have done so without the incentive payment. However, the manager also stated that CARB does not have any data to show what proportion of eligible vehicles were purchased with an HVIP voucher or what proportion of total heavy-duty vehicle purchases in California are for HVIP-eligible vehicles. When we asked for such data, the manager acknowledged that CARB has only anecdotal information from vehicle manufacturers who indicated that all or a majority of their zero- or low-emission vehicle sales occur because of incentives like HVIP. Further, the manager stated that

CARB presumes there are few purchases of HVIP-eligible vehicles as a proportion of total heavy-duty vehicles because they are more expensive than conventional vehicles. However, without actual data, improved surveys, or both, CARB cannot confirm its assumptions that HVIP participants would not have purchased their vehicles without the incentive.

CARB is also missing an opportunity to use data to design programs that maximize their effects on consumer behavior and therefore on GHG emissions. As Table 1 shows, CARB has made changes to only one program, CVRP, based on behavioral considerations. The manager for CVRP explained that over the seven years that CARB has collected survey data, it has used the data to inform and support program changes, and provided documentation of one such change—a limit on the price of vehicles for which consumers can receive CVRP rebate—approved in October 2019. Specifically, the external program administrator for CVRP noted that according to the program’s survey data, as the cost of a vehicle increases, the influence of a rebate on the purchasing decision decreases. The CARB program manager told us that CARB considered this survey result when determining the maximum price for eligible vehicles. However, our review of the survey data raised other questions about participant behavior that CARB could not answer. Between 2013 and 2019, 41 percent to 54 percent of respondents stated that they would have purchased their vehicle even without receiving the CVRP rebate. The CVRP manager explained that CARB knows that there are free-riders in any incentive program. However, the manager also stated that CARB has not reached any conclusions about what these responses indicate for CVRP’s effectiveness and although the response rates can help justify general changes to CVRP, CARB has not specifically used these response rates to make any policy changes to the program.

CVRP Rebate Amounts as of July 2020

Standard maximum rebate amounts:

- Hydrogen-fueled electric vehicle: \$4,500
- Battery electric vehicle: \$2,000
- Plug-in hybrid electric vehicle: \$1,000
- Zero-emission motorcycle: \$750

Maximum rebate amounts for low-income consumers:

- Hydrogen-fueled electric vehicle: \$7,000
- Battery electric vehicle: \$4,500
- Plug-in hybrid electric vehicle: \$3,500
- Zero-emission motorcycle: \$750

Source: CVRP implementation manual as of July 2020.

In 2015 CARB approved an increase to the CVRP rebate for lower-income consumers; the text box lists the current amounts of both the standard and increased rebates. Afterward, CARB added a question to the CVRP survey to ask consumers who received the increased rebate whether they would have acquired their vehicles without the increased rebate amount. The responses to the survey indicated that about half of the participants who had lower incomes and received higher rebate amounts answered that they would have acquired their clean vehicles even without the extra payment—a higher proportion than responded this way regarding the smaller, standard rebate. This result raises questions about whether the increased

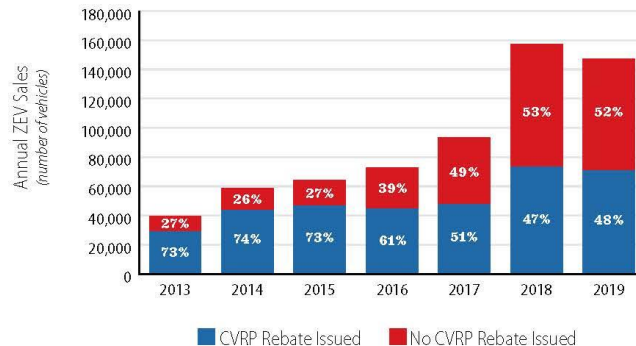
amount is effective in changing consumer behavior. However, when we asked CARB what the survey results indicated about the program, the CVRP manager explained that CARB has not used this aspect of the data to make any program changes though the manager went on to say that CARB would likely review it to examine the efficacy of the additional rebate.

CARB may be missing opportunities to use other sources of data to learn more about how effective its programs are in changing behavior. For instance, in addition to CARB's CVRP rebate, the federal government provides a federal income tax credit for certain electric vehicle purchases. The federal income tax credit can be as much as \$7,500 for certain battery electric vehicles, which is more than CARB's maximum CVRP rebate of \$4,500 for the same type of vehicle. Because the federal income tax credit program is limited to a certain total number of qualifying vehicles per manufacturer, the applicability of the federal income tax credit program for these types of electric vehicles will phase out over time. CARB could use the expiration of the federal income tax credit to help it assess the tax credit's effect on behavior and use that information to evaluate the effectiveness of CVRP. For example, if consumers stop buying vehicles that are no longer eligible for the tax credit, it might mean that incentives cause consumers to purchase vehicles but that CVRP's current rebate amounts are not a great enough incentive on their own.

In addition, CVRP rebates make up a smaller percentage of ZEV sales in California than they did previously. Figure 4 shows that CVRP rebates have declined in proportion to total ZEV sales in the State over the last six years. Although CARB attributes this trend to an income limit for CVRP eligibility that CARB implemented in 2016 at the direction of the Legislature, it has not analyzed its data or the broader ZEV market to confirm the reason for the trend. There may be value in learning why consumers who purchase ZEVs without rebates decide to do so, but the CVRP manager explained that CARB has not conducted such an analysis because to do so CARB would likely need help from car dealerships, who are generally uncooperative and would not participate unless paid to do so. However, the manager did not describe any formal efforts CARB has made to collect such information. Although potentially challenging, collecting and analyzing data from these additional sources—along with better use of its own survey tools—could help CARB understand the extent to which its programs change consumers' behavior and thereby help CARB better measure its programs' actual emissions reductions. Understanding its programs' current effects on participant behavior might also help CARB make changes in those programs to increase their cost-effectiveness and have a greater impact on emissions reductions.

Although potentially challenging, collecting and analyzing data from additional sources—along with better use of its own survey tools—could help CARB understand the extent to which its programs change consumers' behavior.

Figure 4
CVRP Rebates Account for a Decreasing Share of ZEV Sales in California



Source: Analysis of published CVRP rebate information from CARB's program administrator and ZEV sales information from the California Energy Commission.

CARB Has Not Assessed Its Programs' Effect on Other Behavioral Changes That Are Necessary to Achieve GHG Reductions

We also reviewed whether CARB measures its programs' impacts on other aspects of participant behavior that CARB depends on to achieve GHG reductions. For example, some of CARB's pilot programs fund low- or zero-emission transportation services, such as car-sharing programs and vanpools. CARB intends for these programs to reduce GHG emissions by getting people to change their driving habits. CARB has planned to use the data gathered and lessons learned from these programs to identify opportunities to develop expanded programs in the future. A second kind of CARB pilot program provides funding for clean vehicles, such as zero-emission buses, to transit agencies and other entities to support larger-scale deployments of ZEVs, thereby accelerating their introduction and market penetration. Ultimately, this second kind of pilot program seeks to encourage more widespread use of these clean vehicles in California. Knowing whether these programs have the intended effects is crucial to determining their effectiveness at reducing GHG emissions, both now and in the future. However, CARB has not done enough to accurately measure the programs' effects on participant behavior.

For example, CARB operates a car-sharing pilot program that provides funding to establish car-sharing fleets in or near disadvantaged communities to offer alternative modes of transportation and encourage the use of clean cars. Through

this program, CARB has awarded funds to several program administrators throughout the State to implement various kinds of car-sharing projects that use clean vehicles. CARB's emissions reduction projections for the pilot program assume that all of the trips taken in the shared clean vehicles replace trips that would otherwise be taken in a conventional car. However, as our consultant identified, this assumption would overstate the program's emissions reduction if trips that participants made in clean vehicles instead replaced trips on public transit or by walking. Therefore, CARB should determine if the assumptions in its methodology are supported by participants' behavior. One way to do so would be to collect information from participants about how they previously made the trips they now take in the shared clean vehicles.

However, it is not clear whether CARB will have appropriate data to reliably measure the program's behavioral changes. The branch chief who oversees the car-sharing pilot program and the program's manager told us that CARB does not have data about changes in program participants' behavior. CARB requires the program administrators for the individual car-sharing pilots to conduct initial and follow-up surveys of program participants. However, CARB was not able to provide follow-up surveys for two of the pilots, explaining that it is working with its program administrators to determine timelines for the follow-up surveys and that all of the pilots have seen delays. When we reviewed the follow-up surveys for the four pilots CARB has collected so far, we found that the surveys for only two contained questions that could allow CARB to identify what kind of transportation participants replaced with shared vehicles. Subsequently, in January 2021, CARB provided a recently approved, additional follow-up survey for one of the two pilots that was previously missing the necessary information. Although the new survey does contain one such question, this pilot began in 2015 and we are concerned that CARB did not better ensure the collection of this information earlier in the program's existence, which would have allowed CARB to more closely monitor the program and be certain that it has the data it needs to evaluate its assumptions.

Further, it is not clear that CARB will have better information when the car-sharing pilot program has ended because grant agreements do not consistently specify what data the follow-up surveys must contain. Without ensuring that it has this information and that the information is complete and usable, CARB cannot verify its assumption or determine precisely how effective its car-sharing pilot program is at reducing GHGs. The branch chief explained that a program evaluation contract CARB signed with the University of California, Berkeley (UC Berkeley) in May 2020 should provide

It is not clear whether CARB will have appropriate data to reliably measure the car-sharing pilot program's behavioral changes.

CARB does not have sufficient data on the longer-term behavioral changes that some of its pilot programs for heavy-duty vehicles intend to achieve.

insight into the impacts of pilot programs, including the car-sharing pilot program, on users' lives. However, results from this evaluation will likely not be available until 2022.

CARB also does not have sufficient data on the longer-term behavioral changes that some of its pilot programs for heavy-duty vehicles intend to achieve. For instance, CARB operates a bus pilot program that provides grant funding to enable transit agencies and other entities to acquire multiple zero-emission buses and associated infrastructure, such as charging equipment. CARB intends for the pilot program to help the participating agencies address challenges in deploying zero-emission buses and to encourage those agencies and others to transition more of their fleets to zero-emission buses, thereby reducing GHGs. To know whether the pilot program is having the intended effect, CARB stated that it measures behavior changes for participants in its bus pilot program by tracking whether participating transit agencies go on to invest in additional clean buses during or after the end of the pilot program. If they do, the program may be responsible for more considerable GHG reductions over the longer term. Achieving such long-term reductions is a goal of CARB's pilot programs in general.

Further, the information that CARB uses to measure behavioral changes related to the bus pilot program does not allow it to fully determine whether the program has had its intended effect. Specifically, the information indicates which participating agencies applied for other incentive programs from CARB or other agencies to purchase additional buses. However, that information alone does not allow CARB to conclude that the bus pilot program was the reason for the subsequent vehicle purchases. Without collecting and reviewing data about why participating agencies do or do not choose to acquire more clean buses after participating in the bus pilot program, CARB cannot be certain that the pilot program is responsible for changing agencies' behavior.

CARB staff also referred us to another current contract with a third party for some of its heavy-duty vehicle programs, which it expects will help it determine whether its pilot programs are successful, including the bus pilot program. However, the contract's scope of work does not include any specific requirement to ask participants whether they would have changed their purchasing behavior if they had not participated in the pilot program. The scope of work includes an evaluation of whether the vehicles in the pilot program can replace conventional vehicles and the practicality of widespread adoption of those vehicles. Although CARB entered into this contract in 2017, final reports that include the contractor's analysis of the technology and participant experiences for the program's various individual pilots were not yet completed at the time of our review in October 2020.

Better Program Measurement Would Help the State Maximize Its Efforts to Reduce GHG Emissions

CARB’s inability to measure the GHG reductions from its incentive programs diminishes the usefulness of the information the State uses to fight climate change. Currently, CARB’s reporting to the Legislature on the effectiveness of its incentive programs does not accurately estimate the emissions reductions that each of its programs achieves. CARB has responded to other specific questions from the Legislature about how the State can use its programs to pursue longer-term emissions reductions. However, CARB’s lack of information about how its programs change consumer behavior and its imprecise metrics for defining success have limited the usefulness of its responses to the Legislature.

As we describe in the Introduction, CARB reports annually to the Legislature on the estimated GHG emissions reductions its programs achieve as well as the programs’ costs. For the nine incentive programs our consultant reviewed, CARB generally estimates GHG reductions based on the number and types of vehicles for which it paid incentives during the year.⁴ For instance, CARB estimates the GHG reductions from CVRP by calculating the difference between the emissions for the clean vehicles participants purchased and the emissions of an average new vehicle CARB assumes the consumer would otherwise have purchased. CARB then multiplies those reductions by the total number of vehicles the incentive helped pay for. This approach is generally consistent across CARB’s incentive programs that we reviewed.

Although this is reasonable on a per vehicle basis, CARB’s approach leads it to overestimate its incentive programs’ total GHG reductions because it does not account for the effects on industry and consumer behavior of regulatory programs and other factors we have discussed, such as the federal tax credit. Instead, CARB assumes that the emissions reductions from all of the vehicles funded by an incentive program would not otherwise have occurred. By attributing all vehicles to a program without considering these other factors, CARB is overstating the programs’ benefits in its annual reports to the Legislature though it is unclear by how much. One effect of this overstatement is to obscure the programs’ cost-effectiveness in reducing GHG emissions. Taking the steps we describe in the previous section to account for the incentive programs’ overlap with regulatory programs, as well as to improve efforts to ensure that incentive programs cause consumers

CARB is overstating the incentive programs’ benefits in its annual reports to the Legislature though it is unclear by how much.

⁴ The solicitation for one of our 10 selected incentive programs, the Zero-Emission Drayage Truck Pilot, was not released until November 2020, and we therefore did not include it in our review of GHG emissions reductions.

Without accurate information in CARB's annual reports, the Legislature's ability to make decisions about its investments to help the State achieve its GHG emissions goals may be hampered.

to make choices they otherwise would not, would help CARB get closer to identifying—and reporting—the actual emissions reductions its incentive programs achieve.

As the primary report on the status and outcomes of all programs funded by cap-and-trade—including the programs that CARB operates—CARB's annual report must contain accurate estimates of the GHG emissions reductions the funds have achieved.

The Legislature has referenced GHG emissions reductions that programs achieve when it has codified programs into state law. For example, effective in 2018 the Legislature established in law the Clean Cars 4 All program, which previously had been a pilot program that CARB operated only in certain parts of California. The Legislature indicated that one of the reasons for expanding the program and making it permanent was the GHG emissions benefits that the pilot program had achieved. The annual reports also contain information that the Legislature has relied on, in part, when considering other changes to state law regarding how cap-and-trade funds are spent. Without accurate information in the annual reports—which would make these reports a reliable emissions measurement tool—the Legislature's ability to make decisions about its investments to help the State achieve its GHG goals may be hampered. Specifically, if the annual reports contain accurate information, these reports can better help the Legislature make decisions about whether to continue funding a given program at its current level, decrease funding and use those resources elsewhere, or significantly increase funding to help the State achieve its GHG emissions goals.

In addition to the annual reports, the Legislature has required that CARB publish information about how certain programs will help CARB meet the State's goals. For example, the *Supplemental Report of the 2018–19 Budget Act* required CARB to update its forecast annually to indicate how much CVRP funding will be necessary to meet the State's objective of five million ZEVs on the road by 2030. However, because CARB stated that it does not have data to calculate how CVRP drives ZEV sales or how other factors may change the future need for CVRP rebates, CARB could not be fully responsive to this question in the analysis it included in its fiscal year 2019–20 funding plan. CARB responded to the Legislature's request by assuming that five million vehicles would be sold and used historical rebate payment information to calculate the price to the CVRP program. Because it assumed that CVRP would provide rebates for half of the ZEVs sold in California based on its historical data, CARB projected that it would ultimately need to pay out 2.1 million rebates totaling \$5.6 billion to get five million ZEVs on the road, although it noted that it would not reach that goal until after 2030, given the current ZEV market. This approach suggests that CVRP payments are merely a by-product of ZEV

sales and does not provide the Legislature information about how to use CVRP funding to actually generate ZEV sales. The CVRP program manager indicated that CARB took the approach it did with the data it had available. However, we believe that if CARB pursued some of the analysis and data we describe in the previous section, it could offer useful information about how to invest in its incentive programs.

The Legislature has also asked CARB about its plans for meeting longer-term objectives. Effective January 2019, it directed CARB to establish a three-year investment strategy that includes estimated funding needs for zero- and near-zero emission heavy-duty vehicles and equipment to meet certain state goals, including lessening the impacts and effects of climate change. The strategy identified several key areas in which CARB's heavy-duty incentive programs must be successful in order to meet the State's goals, including support for the future evolution of cleaner technology. In the strategy, CARB explained that current technology is insufficient to meet California's long-term air quality and climate change goals. Therefore, CARB intends its incentive programs to support the development, improvement, and commercialization of cleaner technology until the technology can either be supported with other programs or exist without the support of the programs.

However, CARB has not yet adequately defined the metrics it will use to determine when the incentive programs have successfully accomplished these goals. Instead, CARB's strategy identifies anecdotal evidence about production costs and observations about the use of technologies as metrics for determining the programs' success. CARB program managers stated that the metrics do not include quantifications or indicators of success because it is still working to identify and develop what those should be. CARB explained that before the publication of the next strategy document for fiscal year 2021–22, it will continue to work with stakeholders to identify what data are available that could be used to measure whether a technology can transition to a different program or stand on its own. One of the program managers stated that ideally, when the next strategy is published, a few of the metrics will have more details about how CARB plans to quantify success and determine whether a technology is able to transition out of the program. We are concerned that CARB has not yet identified quantifiable metrics to determine when its heavy-duty programs have succeeded in supporting a new technology. The state law requiring CARB to develop this investment strategy took effect in January 2019 and CARB has identified the need to evaluate the effectiveness of its investments in HVIP since at least 2014. Until it has developed these informal metrics into measurable objectives, CARB will

CARB has not yet adequately defined the metrics it will use to determine when incentive programs have successfully accomplished their respective goals.

To ensure the effective future use of state resources to fight climate change, CARB must have plans for how it will phase out or adjust incentive programs when those programs have met their goals.

be limited in its ability to know when an incentive program has succeeded in supporting new technology to the point that it can either be supported by a different program or stand on its own.

Lastly, to ensure the effective future use of state resources to fight climate change, CARB must have plans for how it will phase out or adjust incentive programs when those programs have met their goals. However, CARB's investment strategy for heavy-duty vehicle programs does not include details for phasing out relevant incentive programs, and staff were not able to provide them when we asked whether CARB had formal projections for when HVIP would no longer be necessary to support a specific kind of technology. Planning for how long CARB's incentive programs will be needed is part of ensuring the success of its other programs as well. For example, in 2019 CARB established a regulatory program that will require, beginning in January 2029, all new bus purchases by transit agencies in California to be for zero-emission buses. CARB recognized that a transition of the bus fleet to entirely zero-emission buses could be challenging for transit agencies and, as a result, identified its commitment to using incentive programs to help with the transition. However, some transit agencies have told CARB that the zero-emission buses currently in production do not serve all of their needs. Accordingly, the program manager explained to us that HVIP may still be needed to support and develop the market for zero-emission buses after the regulatory compliance dates have passed. The manager also acknowledged that CARB does not have a projected date for when HVIP incentive payments for zero-emission buses will no longer be necessary. Although making these projections will likely be challenging for the newest technologies, CARB must work to establish clear metrics for when incentive programs have achieved their goals as well as strategies for how to use those resources thereafter. Without doing so, CARB risks continuing to fund programs that are no longer needed to actively support GHG reduction objectives.

CARB's Measurement of Emissions Reductions Suffers From Errors and Issues With Its Programs' Underlying Data

CARB has not done enough to ensure that the reductions in emissions it reports are fully supported by program data. Our review of CARB's emissions reductions in its most recent annual report found several errors in the calculations CARB reported to the Legislature—some of them significant. In other cases, CARB cannot provide documentation to support the accuracy of the data it uses in its aggregate reports. Finally, CARB's inability thus far to measure emissions by region creates uncertainty about a statewide transportation program it administers with regional planning

organizations, and it undermines the State’s ability to identify and pursue the best regional strategies to ensure that the program is successful in reducing GHGs.

CARB Has Not Done Enough to Ensure the Accuracy of the Data It Reports

The emissions reductions that CARB has included in its annual report to the Legislature have not always been accurate and fully supported by its program data. CARB estimates emissions reductions using the methodologies we describe in the preceding section—generally based on emissions reductions calculated from the number and type of vehicles for which it provided incentives—and the data it receives from the program administrators who handle the daily operations of CARB’s incentive programs. Those data contain the number of incentives paid for low- and zero-emission vehicles and specifics about the vehicles, such as vehicle type, engine specifications, and model year. With assistance from our consultant, we reviewed CARB’s calculations of emissions reductions for the most recent annual report, issued in March 2020. Our review found that CARB’s calculations were generally accurate, based on the methodologies for those programs. However, we found instances in which CARB incorrectly applied its own methodologies and therefore made errors in its calculations. One of these errors had a relatively small impact. Specifically, CARB overstated the GHG reductions by 3 percent for heavy-duty vehicles with a specific type of engine—one of several types of vehicles supported by the HVIP program.

However, errors affecting other programs had larger impacts. For example, CARB used the wrong time frame for its CVRP and Financing Assistance programs when calculating the emissions reductions for vehicles those programs helped pay for. As a result, CARB underestimated the amounts it reported to the Legislature for those programs’ emissions reductions by more than 40 percent during the second half of the 2019 reporting cycle, which is included in the 2020 annual report. After we raised these errors in the CVRP, Financing Assistance, and HVIP calculations with CARB, program staff informed us that they had already found and corrected internally some of the errors and would work to correct the others. However, we believe these are errors CARB should have identified before publishing the annual report. Further, at the time of our review, CARB had not provided any corrected emissions estimates to the Legislature. Additionally, for the Clean Cars 4 All program, staff were unable to provide documentation to support CARB’s emissions reduction calculations for the entire second half of the 2019 reporting cycle, which is also included in its 2020 annual report. Without retaining this supporting

We believe CARB should have identified the errors in its annual report before publishing it.

CARB has not always ensured that the program activity it includes in its annual reports is fully supported by underlying program data.

documentation, even for recent years, CARB cannot demonstrate that the program accomplishments included in its annual reports are accurate.

CARB also has not always ensured that the program activity it includes in its annual reports is fully supported by underlying program data. CARB staff aggregate detailed data from the program administrators to summarize a program's total incentive payments and emissions reductions in its annual reports. For the five programs we reviewed that provide incentive payments or other financial incentives to support consumers' vehicle purchases, we used a selection of data from the years 2016 through 2020 to compare the programs' underlying data to the totals given in CARB's annual reports. We found that the data for two of the programs did not align with the total incentive payments in its annual reports. For CVRP, we found discrepancies between the cap-and-trade spending totals in the program data and the totals CARB reported to the Legislature. Although these discrepancies were relatively small—an average difference of 7 percent of the total dollar amount reported by CVRP—they occurred in each of the four reporting cycles we reviewed going back to 2016. Program staff were unable to adequately explain the discrepancies. We did not fully assess the underlying data for the Financing Assistance program because CARB staff informed us that they had already identified inaccuracies in the data that had affected the annual public report. The program manager explained that errors, including incentive payment amounts and omitted data, had led CARB to report inaccurate information over the history of the program, which began in 2015.

Finally, CARB has not taken sufficient steps to ensure the accuracy of the program data it uses in its calculations. Because CARB relies on its program administrators to compile and provide program data, we reviewed how CARB ensures that the data they compile are accurate. Program staff explained that CARB relies on what it refers to as *desk reviews* to ensure that the data are valid and supported by appropriate documentation. During these reviews, CARB examines the documentation for specific incentive payments to determine whether the vehicle data for those incentive payments are accurate, among other tasks. Significant inaccuracies in the data could affect estimated emissions reductions as well as undermine CARB's efforts to track the specific types of vehicles its incentives pay for as part of longer-term efforts to support emerging technology. Even so, CARB has completed these desk reviews for only two of the five programs we reviewed that make such payments to consumers—HVIP and CVRP.

Further, we have concerns about the frequency of the reviews and the evidence CARB maintains to support its conclusions. CARB has not conducted any desk reviews for HVIP since 2014 and has conducted only two reviews for CVRP—in 2014 and 2020. The report from the 2020 CVRP desk review indicates that CARB staff did not identify documentation issues, and CARB staff told us that the issues it identified in its 2014 HVIP review would not have been significant enough to affect emissions reporting for the program. Nonetheless, the documentation CARB maintained from the reviews is not sufficient for us to independently determine whether that is the case. Managers for HVIP and CVRP stated that they also work less formally with the program administrators to review supporting documentation on an ongoing basis. However, given the importance of the program data to CARB’s reporting and broader GHG objectives, more frequent and widespread formal reviews are needed across CARB’s incentive programs.

CARB has not conducted any desk reviews for HVIP since 2014 and has conducted only two reviews for CVRP—in 2014 and 2020.

A Regional GHG Reduction Program Is Failing, but CARB Has Not Collected Data to Determine Why

As we discuss in the Introduction, CARB also provides statewide oversight for the Sustainable Communities program, which is intended to help the State reach its 2030 GHG goals by reducing vehicle travel and therefore GHG emissions. State law requires certain regional planning organizations (governed by local officials) to prepare strategies designed to achieve regional GHG emissions reduction targets. The strategies are aimed at reducing per capita GHG emissions from passenger vehicles, which they do largely by reducing vehicle travel. Pursuant to state law, CARB established specific GHG reduction targets for the 18 distinct regional planning organizations throughout California, which account for nearly all of the population in the State. State law also requires CARB to review the strategies submitted by the regional planning organizations. In approving the strategies, CARB must determine whether the strategies, if implemented, will achieve the GHG reduction targets it set.

Although CARB has updated the Legislature on the progress of the Sustainable Communities program, that update did not contain key information needed to evaluate the program’s success. Beginning in 2017 the Legislature required CARB to assess the progress made by each regional planning organization toward meeting the GHG emissions reduction targets set by CARB and to report that information to the Legislature every four years. In its first and only report thus far, released in November 2018, CARB reported that California is not on track to achieve the program’s GHG reduction targets. However, CARB did not report the progress made by each regional planning organization in meeting the regional targets,

CARB's inability to measure GHG emissions by region creates uncertainty about the future success of the Sustainable Communities program.

as required by state law. CARB explained in the report that it was unable to find a data source to report that information accurately, and it instead reported changes in GHG emissions statewide. In doing so, CARB concluded that passenger vehicle emissions had not declined as significantly as expected and that vehicle travel had actually increased. Accordingly, CARB concluded that the regional planning organizations either were not implementing the strategies or were not achieving the expected results. However, because CARB did not identify GHG emissions changes by region, it could not determine which of these explanations was more responsible for the lack of emissions reductions or whether any regional strategies were actually working. CARB also could not determine which specific types of activities might be successful in reducing GHGs via reductions in vehicle travel.

CARB's inability to measure GHG emissions by region creates uncertainty about the future success of the Sustainable Communities program. When we asked CARB about its progress in finding a data source for regional GHG emissions, it indicated that it had not found one and does not know whether it will have regional data in time for the 2022 report. As a result, we are concerned that CARB and the State may not be able to identify and pursue the best regional strategies for reducing emissions in time to help the State meet its 2030 GHG goals.

Recommendations

To improve its ability to isolate each of its incentive programs' additional GHG reductions, by February 2022 CARB should establish a process to formally identify its incentive programs' overlap with other programs that share the same objectives. As part of that process, CARB should document how it will account for the overlap to allow the most accurate program measurement possible.

As part of its work to measure both incentive and regulatory programs' additional GHG reductions, by February 2022 CARB should begin collecting and analyzing the data it needs to assess the extent to which the requirements in its regulatory programs are being exceeded by manufacturers. To the extent applicable, that analysis should focus on the components of the requirements that overlap with CARB's incentive programs, such as the extent to which manufacturers are complying with regulations for heavy-duty vehicles via low- and zero-emission vehicles.

To improve its ability to identify the effectiveness of each of its incentive programs in reducing GHG emissions, by August 2021 CARB should develop a process to define, collect, and evaluate data on the behavioral changes that result from each of its incentive

programs. Having done so, by February 2022 CARB should collect and analyze relevant survey information for all consumer-focused incentive programs, as well as information about the behavioral effects of programs that other entities offer, such as the federal tax credit.

To better assist the State in achieving its GHG goals, CARB should use the information we describe to refine its GHG emissions estimates for its incentive programs in its annual reports to the Legislature, the funding plans approved by its board, and any longer-term planning documents or reports.

To promote transparency and inform stakeholders, beginning in December 2021, CARB should prepare an annual report for its board and the Legislature on its progress in isolating the GHG emissions reductions attributable to each of its regulatory and incentive programs. As a part of this report, CARB should identify any measurement challenges that persist and highlight any administrative barriers that prevent it from obtaining the information it needs to perform better analysis.

To strengthen the accuracy and integrity of its emissions reduction reporting, CARB should immediately begin retaining all supporting documentation it uses to perform calculations of GHG reductions for its cap-and-trade-funded incentive programs for a period of at least five years. In conjunction with this change, CARB should also document the justification for any instances in which the underlying data it uses to compile its annual reports vary from the information it publishes in those reports.

To better ensure the accuracy of its program data, by August 2021 CARB should develop a formal schedule and procedures for reviewing the supporting documentation maintained by its program administrators. These procedures, which CARB should begin using with the 2022 annual report, should specify a minimum number of records to review in relation to the program's size, should specify how staff will collect and maintain evidence to support conclusions, and should be standardized across all of CARB's incentive programs.

To ensure that the State is positioned to assess the status of the Sustainable Communities program, by April 2021 CARB should report to the Legislature whether it will have a usable source for measuring regional GHG emissions in time for the 2022 report. If CARB believes it may not, it should identify any administrative or bureaucratic barriers it faces in accessing data it needs for the estimates and request relevant action by the Legislature to make those data available.

40 | California State Auditor Report 2020-114
February 2021

Chapter 2

CARB HAS NOT ADEQUATELY DEMONSTRATED ITS PROGRAMS' SOCIOECONOMIC BENEFITS

Chapter Summary

State law requires CARB to spend a portion of its cap-and-trade funds to provide benefits to disadvantaged communities as well as low-income communities. The history of these requirements demonstrates the Legislature's desire to target cap-and-trade funding in a way that provides benefits for Californians most in need. However, although in recent years CARB has exceeded the minimum requirements in state law for program spending in disadvantaged and low-income communities, it has significant opportunities to better evaluate and demonstrate its programs' effectiveness.

CARB operates incentive programs that it intends to have specific, tangible socioeconomic benefits for participants. However, it does not consistently collect data to determine whether the programs actually provide those benefits. CARB has also missed opportunities to use data it has already collected to determine whether participants are receiving the intended benefits. Finally, CARB has been slow to measure the jobs its programs are required to support, and it has not done enough to measure the benefits of the job training activities that its own guidelines require. Given that programs designed to provide socioeconomic benefits may cost more than other CARB programs and do not focus primarily on GHG reductions, it is crucial that CARB effectively define and measure the socioeconomic benefits they provide.

The Legislature Has Shown a Desire to Focus Benefits on Californians Most in Need

Requirements in state law for cap-and-trade spending in disadvantaged and low-income communities have become more specific over time. As discussed in the Introduction, disadvantaged communities are classified based largely on their sensitivity to environmental pollution, while the low-income community classification is based solely on income statistics. In 2013 state law required CalEPA to identify disadvantaged communities in California. CalEPA performed this identification by zip code based on a range of factors that focused primarily on sensitivity to the physical environment, such as air pollution. At that time, state law

required a minimum of 25 percent of all cap-and-trade funds to benefit these disadvantaged communities, with 10 percent to be spent on projects located within those communities.

The original approach to identifying disadvantaged communities proved to be too broad. In 2014 CalEPA determined that identifying communities by zip code did not allow for enough precision and changed the identification of disadvantaged communities from zip codes to census tracts—smaller geographical areas determined by the U.S. Census Bureau with assistance from local entities and intended to allow statistical comparisons. This change allowed for a more detailed assessment of each community’s status because there are more than four times as many census tracts as there are zip codes in California, and census tracts are established with the goal of having roughly equivalent populations. Even with this change, some of the cap-and-trade funds counted toward the required minimum spending under the state law in effect at that time even if those funds benefited disadvantaged communities but were not spent on projects located within those communities. Under this approach to defining eligible spending, many cap-and-trade dollars were not spent within the disadvantaged communities most in need. For example, our review of two of CARB’s largest incentive programs found that in 2016 significant proportions of spending categorized as benefiting disadvantaged communities took place outside those communities’ borders. Specifically, program data indicate that HVIP spent nearly one-third of its \$8.4 million in disadvantaged community spending in areas physically outside of disadvantaged communities; for CVRP it was more than 80 percent, or \$34 million, of its total \$42 million in reported disadvantaged community spending.

In 2016 the Legislature amended state law to focus cap-and-trade spending primarily on projects located within the boundaries of, and benefiting individuals living in, disadvantaged communities.

Acknowledging the need to better target cap-and-trade spending, in 2016 the Legislature amended state law to focus this cap-and-trade spending primarily on projects located within the boundaries of, and benefiting individuals living in, disadvantaged communities. The amended law significantly limited the amount of cap-and-trade spending that could take place outside of disadvantaged communities and still be considered as benefiting those communities. Effective January 2017, the law now requires that all cap-and-trade funds that count toward the disadvantaged community funding requirement be spent on projects located within the boundaries of the disadvantaged communities.

Also effective in 2017, the Legislature established a cap-and-trade spending requirement for a second group of communities, referred to as low-income communities. Here too the Legislature encouraged a higher degree of precision in focusing the benefits of this cap-and-trade funding on Californians who need them most. Specifically, the amended law defines low-income communities as

census tracts where the median household income is below certain statewide thresholds, defined in part as 80 percent of the statewide median income. The law also requires 10 percent of cap-and-trade dollars to benefit these newly defined communities.

When establishing the low-income community funding requirement, the Legislature again demonstrated a desire to ensure that the new benefits went to Californians most in need. Although defining these communities at the census-tract level was more precise than previous requirements for disadvantaged communities, the Legislature also acknowledged that some of the best GHG reduction strategies are those that benefit low-income households directly, regardless of where those households are located. Accordingly, the amendment, which took effect in 2017, also gives agencies that receive cap-and-trade funds the option to measure and report low-income community spending based on the actual households that the programs benefit, as opposed to reporting only at the census-tract level.

In recent years, CARB has exceeded the minimum spending requirements for disadvantaged and low-income communities. In its 2020 annual report, CARB reported that the State has spent a cumulative 39 percent of its cap-and-trade funding in and benefiting disadvantaged communities and 21 percent of funding in and benefiting low-income communities since August 2017. Further, our review of selected programs found that CARB generally exceeded the separate minimum 25 percent and 10 percent requirements for each of those programs. For example, in 2019, program data show that CARB spent nearly 50 percent of its total cap-and-trade funding for HVIP in disadvantaged communities and more than 15 percent in low-income communities, both well over the required minimum. However, CARB's reporting could be more precise. Specifically, for the consumer-based programs we reviewed, CARB reported spending in low-income communities at the census-tract level and not in terms of actual households. Reporting at the household level, where possible, would provide more valuable information about programs that serve individuals and families. Further, as we discuss in the following sections, spending in disadvantaged and low-income communities is generally the only information CARB measures or reports regarding the socioeconomic benefits of its programs, even though its programs have specific intended benefits that focus on individuals and households. Given the Legislature's desire to focus and track the non-GHG benefits of cap-and-trade-funded programs, we believe CARB has significant opportunities to better evaluate and demonstrate the programs' effectiveness, including by reporting at the household level.

By reporting at the household level, where possible, CARB would provide more valuable information about programs that serve individuals and families.

Although CARB has identified specific socioeconomic benefits it intends its programs to achieve, it does not consistently collect the data it needs to demonstrate those benefits.

CARB Cannot Sufficiently Demonstrate That Its Programs Achieve Socioeconomic and Jobs Benefits

As required by state law and its own guidelines, CARB operates certain transportation incentive programs to achieve socioeconomic benefits for participants. Although CARB uses cap-and-trade revenue to operate these programs, the programs place more emphasis on the socioeconomic benefits than on maximizing GHG reductions. As a result, the programs may cost significantly more than other incentive programs relative to the GHG reductions they achieve—underscoring the importance of ensuring that they actually provide the other intended benefits. However, although CARB has identified specific socioeconomic benefits it intends its programs to achieve, it does not consistently collect the data it needs to demonstrate those benefits, and it has been slow to collect required socioeconomic data, such as data related to job creation. Further, CARB has missed opportunities to use data it currently collects to ensure that participants are receiving the intended benefits.

CARB Does Not Evaluate Programs to Determine Whether They Achieve Intended Socioeconomic Benefits

CARB's programs that are aimed primarily at producing socioeconomic benefits receive cap-and-trade funding but do not have GHG reduction as their primary goal. CARB categorizes the programs it develops for disadvantaged and low-income communities as *equity programs*. Equity programs that focus on socioeconomic benefits may cost significantly more than CARB programs that focus primarily on reducing GHGs relative to the GHG reductions they achieve because they offer higher incentive payments or require more intensive program administration to provide socioeconomic benefits to participants. For example, CARB's data indicate that the cost to reduce one ton of GHG emissions through CARB's Financing Assistance program is seven times the cost of doing so through its CVRP program. Some of the higher costs come either from the larger cash incentives that the programs provide per vehicle to the low- or middle-income Californians who participate or from the more intensive program administration required to achieve the additional socioeconomic benefits the programs are expected to provide. For example, grant agreements we reviewed for the Financing Assistance program allow 14 percent or more of the total grant funding to go towards personnel costs for the program administrators, who work closely with participants, while the CVRP grant agreement limits administrative costs—including but not limited to personnel costs—to 7 percent. Because equity programs are less

cost-effective in terms of emissions reductions, it is critical that CARB demonstrate each program's value by clearly defining and measuring its socioeconomic benefits.

Although CARB has identified specific socioeconomic benefits that it intends for its equity programs to provide participants, it does not consistently collect data to determine whether the programs actually provide those benefits. As we discuss above, CARB's program administrators for its Financing Assistance program work closely with participants, providing training on financial literacy with required topics such as credit, bank services, and vehicle expenses to ensure consumer protection and increase the chance of successful loan repayment. For example, in its fiscal year 2017–18 funding plan, CARB stated that it intended for the Financing Assistance program to provide economic benefits to participants such as increased credit scores, the ability to qualify for housing loans, and access to more reliable transportation. However, the metrics CARB identified that it will use to measure progress do not allow CARB to actually measure these benefits. Instead, they include the number of consumers who participate, costs and types of vehicles purchased, and loan repayment rates, none of which allow CARB to determine whether the program achieves the intended benefits. Further, over the five years CARB has operated the Financing Assistance program, it has not collected data that would allow it to report on benefits achieved. For example, despite repeatedly citing participants' loan repayment rates as a measure of the program's success in its annual funding plans, CARB does not collect data about or report on these rates. CARB stated it does not have access to this information because the program administrators do not manage the participants' loans, leading us to question why CARB identifies loan repayment as a metric to measure program success. We expect CARB to identify metrics for which it can collect the data and measure the benefits when designing and requesting funding for the program.

CARB also does not collect data that allows it to measure the socioeconomic benefits of participation in its car-sharing pilot program. In its annual funding plans, CARB has described improvements in participants' access to mobility as a metric with which to measure the program's success. When we asked CARB how it measures this metric, the program manager explained that CARB expects to see participants taking trips that they would not have been able to without the program, such as traveling outside of their neighborhoods for medical appointments. However, CARB does not consistently collect this information from participants. Specifically, although the grant agreements require initial and follow-up participant surveys be conducted by the program administrators, they do not require program administrators to ask questions about changes in mobility. Accordingly, the surveys

Because equity programs are less cost-effective in terms of emissions reductions, it is critical that CARB demonstrate each program's value by clearly defining and measuring its socioeconomic benefits.

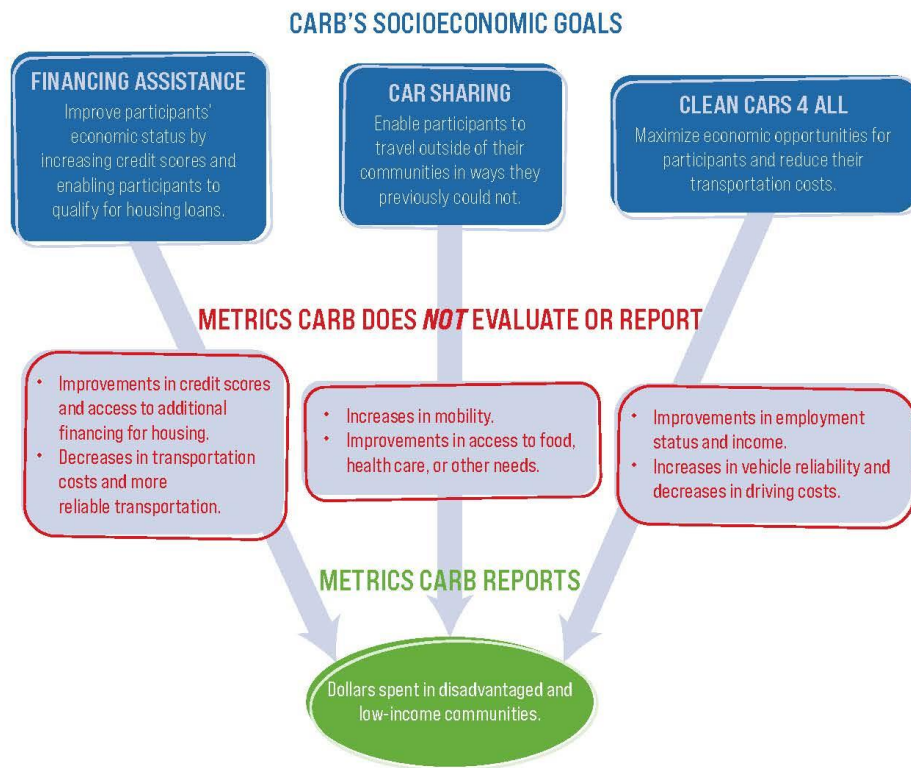
do not consistently collect information about such changes. The program manager also confirmed that CARB has not evaluated its car-sharing pilot program to determine such mobility.

CARB's failure to collect and measure relevant program data greatly limits its ability to inform the Legislature and other stakeholders about whether the programs are effective. As Figure 5 shows, despite the specific socioeconomic goals CARB identified for its programs, its public reporting on their benefits is generally limited to the broad spending requirements we discuss in the first section of this chapter. In May 2020, CARB entered into a contract with UC Berkeley to, among other things, evaluate the socioeconomic benefits of the car-sharing program, including increased access to transportation and increased economic opportunity. However, CARB does not expect a final report on the results from the evaluation until 2022, at which point the program will have been operating for five years without an appropriate evaluation of the benefits it provides to participants.

CARB also does not consistently use the data that are available to demonstrate benefits from programs and determine whether the programs are achieving their goals. CARB's Clean Cars 4 All program provides incentives for lower-income consumers who scrap their old vehicles and purchase new clean vehicles, ostensibly providing more reliable and less costly transportation. Consequently, CARB states that the intended benefits of its Clean Cars 4 All program include maximizing economic opportunities for participants, reducing their cost of driving, and minimizing work interruptions because of unreliable transportation. However, as Figure 6 shows, CARB has missed clear opportunities to assess whether the Clean Cars 4 All program actually provides these socioeconomic benefits. CARB administers the program through grant agreements with local air districts, which perform the day-to-day activities of the program. These grant agreements require the air districts to conduct surveys of program participants. When entering into multiple grant agreements with several air districts, which it did between 2015 and 2020, CARB provided the air districts with identical sets of example surveys. The example surveys include questions that indicate how CARB intended to measure the socioeconomic benefits it expects the program to provide, such as whether participants' employment opportunities have changed as a result of the program and whether their income has changed. CARB could use the results from these survey questions to evaluate whether the program is providing the socioeconomic benefits it expects. However, although the grant agreements require the air districts to conduct surveys of participants, they do not require the air districts to ask specific questions or use the example surveys. Instead, the grant agreements allow the air districts to design their own survey questions. The

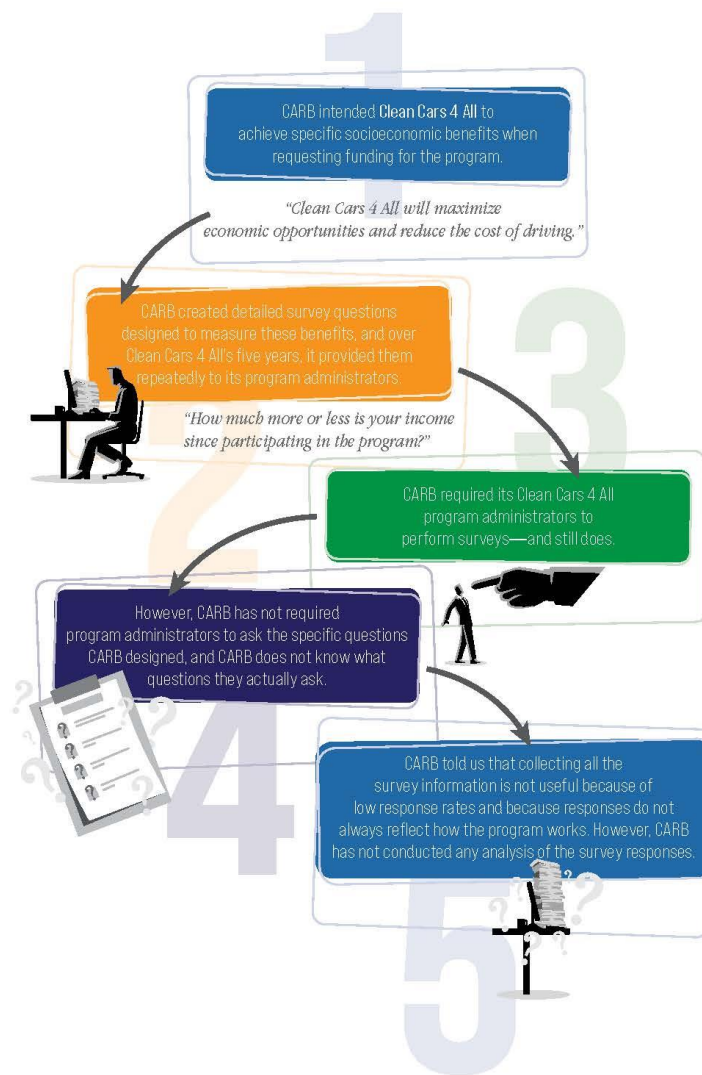
program manager explained that CARB does not have copies of the actual surveys the air districts use because it has not asked for them. As a result, CARB does not know what questions the surveys ask.

Figure 5
CARB Establishes Specific Socioeconomic Goals but Only Reports on Broad Outcomes



Source: CARB's funding plans, 2020 annual report to the Legislature, and interviews with CARB staff.

Figure 6
CARB Has Missed Opportunities to Measure Benefits for Its Clean Cars 4 All Program



Source: CARB's funding plans, grant agreements, and interviews with CARB staff.

CARB has also missed opportunities to use data it currently has to determine whether participants are receiving the intended benefits of its programs and to monitor the effectiveness of those programs. Although greater financial stability for participants is a shared goal of both the Financing Assistance program and Clean Cars 4 All, CARB does not analyze data it collects on program participants that could help it determine whether the programs are contributing to improved financial stability. For both programs, CARB collects data about participants' personal financial circumstances, including details about their household income and vehicle loans—such as loan amounts and interest rates. CARB's manager for Clean Cars 4 All told us that CARB uses the data in these reports to monitor the performance of the air districts, determine whether the districts are meeting statutory obligations in administering the program, and determine funding needs and annual statutory goals. However, that manager also confirmed that CARB has not made any changes to the program based on the data. Similarly, the manager for the Financing Assistance program stated that CARB uses the data in the quarterly reports from its external program administrators to ensure that the program is working but confirmed that CARB has not made any changes to the program based on the data contained in the reports. The manager explained that the programs each have a low volume of data, meaning that it is not useful for analyzing program effectiveness. Given that Financing Assistance is a small-scale pilot program, a low volume of data for the program is reasonable; however, the scale of the program does not prevent CARB from analyzing the available data and using that analysis to inform changes if necessary.

The program data we reviewed show that interest rates for participants' loans vary significantly, with some rates as low as 1 percent and others exceeding 25 percent. Given that helping consumers overcome the barrier of obtaining vehicle financing by providing low-interest loans is a primary purpose of the Financing Assistance program and that CARB intends for Clean Cars 4 All to maximize economic benefits for participants, we expected that CARB would be analyzing the loan information to determine whether the programs are operating as expected and in ways that are beneficial to participants. However, CARB has not formally done so for either program. The Financing Assistance manager stated that CARB expects participants to pay off their loans and avoid vehicle repossession. When we asked whether CARB has formally collected data on vehicle repossessions, CARB reviewed past reports from its two external program administrators and learned that there were five repossessions reported by one and zero by the other. However, CARB has not formally analyzed the information and is accordingly unable to demonstrate whether these numbers indicate that the program is succeeding. These numerous instances of uncollected and unused data prevent CARB

CARB has missed opportunities to use data it currently has to determine whether participants are receiving the intended benefits of its programs and to monitor the effectiveness of those programs.

from determining whether its programs are providing the specific intended socioeconomic benefits. As a result, it also has not been able to inform stakeholders, such as the Legislature, about the extent to which these programs are succeeding.

CARB Has Been Slow to Measure Job Creation and Has Done Little to Evaluate Job Training

CARB has also done relatively little to evaluate the effects of its programs on required job creation and training. As discussed in the Introduction, state law directs CARB, to the extent feasible, to use cap-and-trade funds in a way that fosters job creation by promoting GHG emissions reduction projects carried out by California workers and businesses. In addition, CARB’s own funding guidelines from 2015, the first year it published these guidelines for cap-and-trade-funded programs, direct it to design programs that result in jobs and job training whenever possible. CARB’s 2018 updated funding guidelines expanded on this requirement, specifying that programs’ job creation and training efforts should target disadvantaged and low-income communities and households. Both sets of guidelines include elements for measuring and reporting on the programs’ impact on jobs. The 2015 guidelines specify that CARB should track and report the number of job recipients and trainees funded by its programs, and the 2018 guidelines refined the required reporting to direct the external entities administering CARB’s programs to use a specific job calculator tool to estimate the number of jobs each program supports more broadly.

Despite clear direction and a stated requirement to estimate the number of jobs its programs support, CARB has failed to do so in a timely or comprehensive way.

Despite clear direction and a stated requirement to estimate the number of jobs its programs support, CARB has failed to do so in a timely or comprehensive way. CARB began collecting data in 2019 for only some of its programs about the numbers of jobs they fund and support, and it still does not do so for other programs. Specifically, of the nine programs we reviewed for which jobs reporting requirements apply, CARB had collected jobs data in its reporting database for only three at the time of our review. Further, although it published estimates for some of its incentive programs in its fiscal year 2019–20 funding plan, as of its most recent annual report to the Legislature in March 2020 CARB had not reported any jobs creation numbers for its individual programs. Instead, CARB reported the aggregate jobs numbers for all cap-and-trade programs across multiple agencies, numbers that our review of program data showed were incomplete.

When we asked about its general lack of jobs reporting, CARB staff referenced the difficulty of establishing and implementing the measurement process. Staff also indicated that they have

been unable to require some program administrators to follow the jobs reporting requirement because CARB entered into multiyear agreements with those program administrators before developing the reporting requirement. We find these explanations unconvincing, given that CARB has had since 2015 to implement the funding guidelines and according to a literature review, the jobs calculation tool CARB requires its program administrators to use is based on a method that is relatively simple and widely used for such analyses. We also note that CARB could seek to amend its grant agreements or, failing that, use its own tool to determine jobs benefits rather than relying on its program administrators to do so. Finally, CARB explained that staff had collected jobs data for two of the programs we reviewed where those data were missing, but they had neglected to enter them into CARB's reporting database.

CARB also has requirements for providing job training benefits and reporting on them. As we discuss above, CARB's funding guidelines require it to foster job training for its cap-and-trade-funded programs and to focus its training efforts on disadvantaged and low-income communities and households. The guidelines further specify that CARB should report information on employment outcomes from programs that provide job training, including information on the quantity and quality of the job trainings as well as the wages participants are paid and any credentials they receive as a result of the training activities.

Although the jobs training requirements in CARB's funding guidelines apply whenever possible, we understand that these types of benefits may be more relevant for some programs than for others. Specifically, it might be reasonable for a consumer-focused rebate program like CVRP not to have an explicit job training component. In contrast, pilot programs focused on industry and demonstrating advanced clean technologies have a natural overlap with job training. For example, as we discuss in Chapter 1, CARB operates a bus pilot program that helps transit agencies and other entities acquire zero-emission buses and associated infrastructure. The program is focused in disadvantaged communities, and its goal is to place large numbers of zero-emission buses in service while also providing opportunities for on-the-job training for bus operators and maintenance workers to learn the new technology. Among the 10 incentive programs we reviewed, CARB includes a job training element for only four programs. The fact that job training benefits may be relevant to only certain programs underscores the importance of tracking those benefits when they are provided.

When CARB does include job training as a program benefit, it does not always require its program administrators to provide detailed information about that training or how it benefits participants.

CARB does not always require its program administrators to provide detailed information about that training or how it benefit participants

Grant agreements for the three bus pilots do not include specific requirements for reporting on the quality of trainings, how the training benefits the participants, or where the participants live.

For example, CARB operates a freight program that provides grant funding to demonstrate advanced emissions-reducing technologies for moving freight within and through California and to encourage industry’s development of those technologies. CARB’s grant agreements with the program administrators require them to provide job training. The grant agreements include training materials and completed training rosters as required deliverables but do not require the program administrators to provide any information to CARB about the outcomes of the trainings for participants, the quality of trainings, or whether participants come from the communities CARB is trying to serve. For the two pilots we reviewed under this program, one of the program administrators reported to CARB that trainings were conducted and provided CARB with the training manual as evidence that the trainings occurred. However, the program administrator provided no further information, such as wages paid to program participants, the training credentials they received, or where they live. At the time of our reporting, the other program administrator reported it had not yet provided any training as part of the program.

Similarly, one of CARB’s pilot programs provides grant funding to enable transit agencies and other entities to acquire advanced zero-emission buses and associated infrastructure. We reviewed three of the five bus pilots CARB operates under its bus pilot program and found that the grant agreements for these three pilots include general job training requirements and require the external program administrators to report to CARB the date the training was completed. However, similar to the freight program, the grant agreements for the three bus pilots do not include specific requirements for reporting on the quality of trainings, how the training benefits the participants, or where the participants live.

Notably, we identified one pilot program that has more detailed job training and reporting requirements, but those requirements apparently were included because additional funding was provided. Specifically, CARB and the California Energy Commission (energy commission) are planning to jointly operate a zero-emission truck pilot program that includes funding from both entities. The solicitation documents for the program indicate that the program administrators will be responsible for developing and implementing a workforce training and development plan as part of the program, as well as for including specific data about the training and those who participate. However, the funds supporting these job trainings and detailed reporting requirements are from the energy commission, not CARB’s cap-and-trade funding. In fact, when we asked CARB about the job training for this truck pilot program, it indicated that the program includes these requirements because the energy commission had specific funds to invest in workforce development. Although the energy commission does allocate funds

for job training, CARB's own funding guidelines have, since at least 2015, directed it to include job training as a component of funded projects wherever possible. Therefore, we question why CARB has not included similarly detailed requirements for its own programs to ensure that they meet its own funding guidelines and provide these important benefits.

Recommendations

To ensure that it communicates clearly to the Legislature about the extent to which programs benefit low-income households as the Legislature intended, by March 2022 CARB should begin reporting its spending in low-income communities at the household level wherever possible in its annual report to the Legislature.

To better define incentive programs' impact beyond GHG emissions reductions, by August 2021 CARB should review its incentive programs to ensure that it has clearly designated which programs focus primarily on socioeconomic benefits. As a result of this process, by February 2022 it should ensure that it includes the benefits expected for each program in its funding plan or other public documents, such as its annual report and individual grant agreements.

To better demonstrate the socioeconomic benefits that its incentive programs achieve, by February 2022 CARB should do the following:

- Identify clear and measurable metrics it will use to assess each of the socioeconomic benefits it intends its programs to achieve.
- Develop a process to collect data, or use existing data, to measure and report on each metric.
- In its funding plans and annual reports, CARB should report to the Legislature and its board on the metrics.

To provide transparency to the Legislature and other stakeholders, beginning in 2022 and using the metrics and data described above, CARB should make funding and design recommendations in its funding plans and annual reports based on which programs are effective in producing socioeconomic benefits and at what cost.

To ensure that the State has reliable information about the extent to which cap-and-trade-funded programs create and support jobs, by August 2021 CARB should begin collecting data on the jobs produced by each of its incentive programs. Where needed, CARB should pursue amendments to its agreements with its program

administrators to make reporting this information mandatory. CARB should include an analysis of these jobs data in its annual reports to the Legislature beginning in 2022.

To ensure that its incentive programs promote effective and equitable job training, by August 2021 CARB should develop a process to assess which programs should include a job training element. For those programs it identifies, by February 2022 CARB should direct its staff or its external program administrators to collect and report on the quality of job trainings and outcomes experienced by participants, including who received training, the credentials participants received as a result, any actual or expected wages they received as a result of participating in the training or for developing the relevant expertise, and the number of participants from disadvantaged communities or low-income communities and households.

Other Areas We Reviewed

To address the audit objectives approved by the Joint Legislative Audit Committee (Audit Committee), we also reviewed the subject areas in Table 2. These areas include the risk that regulatory programs may shift GHG emissions outside of California (as opposed to reducing them overall), CARB’s economic analyses for its proposed regulatory programs, and CARB’s tracking of the costs it incurs to administer its transportation programs. Table 2 indicates the results of our review and presents an associated recommendation that we have not already discussed in other sections of this report.

Table 2
Other Areas We Reviewed as Part of This Audit

<p>Transportation Programs Generally Do Not Risk Shifting Emissions Elsewhere</p>
<p>The Audit Committee directed us to examine whether the reduction of GHG emissions resulting from a selection of CARB’s transportation programs were the result of shifting emissions rather than eliminating them. Such shifting may occur if regulatory requirements cause economic activity to move out of state. In such a scenario, there may appear to be a reduction in emissions, but the emissions have just moved elsewhere. We engaged our consultant to help us determine the extent to which emissions reductions from CARB’s programs may result from shifting emissions elsewhere rather than eliminating them. Our consultant concluded that the transportation-related industries regulated by the programs we reviewed are not likely to shift emissions materially. For example, the regulatory programs generally focus on vehicles sold or operating in California, and individuals and businesses cannot easily shift their use of transportation out of state. As such, even when California’s vehicle requirements are more stringent than those in other states, manufacturers cannot avoid the restrictions by making the vehicles elsewhere. Further, for sectors that could experience a shift in activities from California to another location depending on the magnitude of regulatory costs—such as services provided by ports—our consultant identified that CARB has acknowledged these regulatory costs and has adopted certain programs to address them, which may limit the potential shifting of emissions.</p>
<p>CARB Reasonably Projects the Economic Impacts of Its Regulatory Programs, but It Could Do More to Explain the Effects on Consumers</p>
<p>The Audit Committee directed us to identify the cost-effectiveness of the transportation programs we selected for review. Our consultant evaluated the economic analyses that CARB conducted when it proposed the eight regulatory programs we reviewed. Our consultant concluded that CARB reasonably approached its assessment of the compliance costs and resulting cost-effectiveness of all eight of these regulatory programs reviewed. However, our consultant also found that CARB may understate costs in some circumstances and that it could expand its consideration of the costs and benefits to consumers. Specifically, CARB often concluded that the regulatory requirements in its programs, such as requiring the sale of ZEVs, represent net savings to consumers. In one specific analysis, CARB concluded that the long-term cost savings for some vehicles were greater than the additional up-front cost of those vehicles.</p> <p>However, given its conclusion that these vehicles save consumers money, CARB could do more to consider all costs and benefits to purchasing a clean vehicle—such as driving range—and if, in fact, such vehicles are more desirable to consumers, explain why it is necessary to require sales of clean vehicles through its regulatory programs. CARB has not fully analyzed these issues and their implications for the regulation’s rationale and design. We recommend in Chapter 1 of this report that CARB develop a process to define, collect, and evaluate information on what factors influence consumers’ purchasing behavior as a key part of measuring the effectiveness of CARB’s incentive programs. Doing so would also allow CARB to better speak to the necessity of its regulatory programs and the effectiveness of particular designs it proposes.</p>

Tracking Administrative Costs Would Allow CARB to Better Assess Its Programs' Cost-Effectiveness

The Audit Committee directed us to assess, in part, how CARB considers the effects of a proposed program on its administrative costs. For the eight regulatory programs we reviewed, CARB identified its expected administrative costs for the programs when proposing them. However, CARB did not consistently identify its own administrative costs when proposing funding for the 10 incentive programs we reviewed. Some managers explained that they do not estimate administrative costs because they consider overseeing incentive programs to be a part of CARB's everyday responsibilities or because CARB did not know how much it would cost to administer the programs. However, it is clear that the addition of new programs for CARB to oversee represents new costs; therefore, CARB should include those costs in its estimates of the expenses to operate the programs once implemented. Our review determined that CARB also does not track actual administrative costs for its individual incentive programs. As a result, although CARB has spent approximately \$120 million in cap-and-trade funds to administer its programs since 2013, it could not tell us what its administrative costs have been for individual programs. CARB explained that staff may work on more than one program at a time and indicated that it does not yet have a means of tracking staff time or other costs across all programs. However, because these costs are a potentially significant component of the total costs required to operate a given program, CARB should take all reasonable steps to measure them. Moreover, it is a basic and often required task for state agencies to track their costs related to specific programs and activities, and we see no reason why CARB would be unable to do so.

Recommendation

To ensure that it can account for the total costs of its transportation programs, beginning with fiscal year 2021–22 CARB should develop and implement processes to track the administrative costs it incurs to operate each of its transportation programs. After doing so, it should begin including those costs as part of the cost-effectiveness measurements in its annual reports to the Legislature.

We conducted this performance audit in accordance with generally accepted government auditing standards and under the authority vested in the California State Auditor by Government Code 8543 et seq. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on the audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Respectfully submitted,



ELAINE M. HOWLE, CPA
California State Auditor

February 23, 2021

Appendix A

CARB'S TRANSPORTATION GHG EMISSIONS REDUCTION PROGRAMS

The Audit Committee directed the California State Auditor's Office (State Auditor) to identify the number and type of CARB's GHG emissions reduction programs in the transportation sector. This Appendix presents a list of those programs. The green highlights in Table A indicate the programs we reviewed as a part of the audit, which we selected in order to ensure a review of programs affecting a variety of vehicle types and transportation objectives.

Table A
CARB's Transportation GHG Emissions Reduction Programs

PROGRAM NAME	TYPE	DESCRIPTION
1 AB 617 Community Air Protection Program	<i>Incentive</i>	Creates incentive for vehicle owners to replace older, high-polluting vehicles and equipment with newer models that have low or zero emissions. Funds can also support local strategies that air districts and communities identify.
2 Advanced Clean Trucks Regulation	<i>Future Regulation</i>	Will require manufacturers to make a percentage of their truck and bus sales zero-emission and will require certain entities to report once about their use of contracted services that require trucks or shuttles.
3 Advanced Technology Freight Demonstrations	<i>Incentive</i>	Encourages the development of advanced technologies to accelerate their market introduction.
4 Agricultural Worker Vanpools	<i>Incentive</i>	Expands access to clean transportation vanpools for agricultural workers and achieves emissions reduction benefits by providing incentives for cleaner vehicles instead of conventional vehicles.
5 Alternative Diesel Fuels Regulation	<i>Regulation</i>	Intends to create a framework for low carbon diesel fuel substitutes, such as biodiesel, to enter the commercial market in California while mitigating potential environmental or public health impacts.
6 California Climate Investments	<i>Oversight</i>	State law requires CARB to develop guidance on reporting and quantification methods for all state agencies that receive cap-and-trade moneys to ensure that requirements in state law are met. Programs administered with these moneys are referred to as California Climate Investments programs.
7 Cap-and-Trade Regulation (fuels)	<i>Regulation</i>	Establishes a declining cap on emissions from facilities accounting for about 80 percent of the State's GHG emissions and currently covers about 450 facilities, of which more than 50 are fuel suppliers. Such facilities must either acquire credits to offset their emissions or invest in emissions reduction technology to reduce emissions.
8 Car-sharing pilots	<i>Incentive</i>	Helps government entities or nonprofits start or expand car-share programs for residents of disadvantaged communities, using low- and zero-emission vehicles, vanpools, and other mobility options.
9 Carl Moyer Memorial Air Quality Standards Attainment Program	<i>Incentive</i>	Grants funding to private companies and public agencies to purchase cleaner than required engines, equipment, and emissions reduction technologies. Among other things, the program can fund trucks, emergency vehicles, and farm and cargo-handling equipment.
10 Clean Miles Standard and Incentive Program	<i>Future Regulation</i>	Intends to reduce GHG emissions from transportation network company services. State law required CARB to establish a baseline for emissions of GHGs for vehicles used on the online-enabled applications or platforms by transportation network companies on a per-passenger-mile basis.
11 Clean Mobility in Schools	<i>Incentive</i>	Funds the electrification of transportation fleets, including vehicles and infrastructure, plus education and awareness to encourage clean mobility in and around schools located in disadvantaged communities.

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PROGRAM NAME	TYPE	DESCRIPTION
12 Clean Off-Road Equipment Voucher Incentive Project (CORE)	<i>Incentive</i>	Gives vouchers for certain zero-emission freight equipment.
13 Clean Vehicle Rebate Project (CVRP)	<i>Incentive</i>	Supports funding for vehicle rebates on a first-come, first-served basis for light-duty ZEVs. Rebate amounts are increased for lower-income applicants.
14 Drayage Truck Regulation	<i>Regulation</i>	Requires that all trucks servicing ports and railyards be equipped with 2007 or newer model year engines.
15 Electric Vehicle Supply Equipment Standards	<i>Regulation</i>	Intends to increase drivers' ease of access to charging infrastructure. According to CARB, creates a minimum standard of access for public electric vehicle charging and creates a more complete database of location and pricing information for consumer use, among other provisions.
16 Electrify America investments	<i>Oversight</i>	CARB approves the investment plans for how Electrify America, a subsidiary of Volkswagen, invests funding in California to address the adverse impacts to California's ZEV program resulting from the sale of Volkswagen vehicles equipped with emissions defeat devices to consumers who believed they were purchasing clean vehicles.
17 Clean Cars 4 All	<i>Incentive</i>	Creates incentives for lower-income consumers living in and near disadvantaged communities who retire their old vehicles and purchase new or used hybrid, plug-in hybrid, or ZEV replacement vehicles.
18 Financing Assistance for Lower-Income Consumers	<i>Incentive</i>	Supports low interest loans and vehicle price buy-downs to help lower-income Californians overcome the barrier of obtaining vehicle financing for clean vehicles.
19 Funding Agricultural Replacement Measures for Emissions Reduction (FARMER)	<i>Incentive</i>	Awards funds to farmers and agricultural businesses for newer, cleaner equipment.
20 Goods Movement Emission Reduction Program (Proposition 1B)	<i>Incentive</i>	Funds the retrofit, purchase of engines, or replacement of vehicles—including trucks, locomotives, harbor vehicles, transport refrigeration units, cargo handling equipment, and supporting infrastructure.
21 Greenhouse Gas Regulations for Medium- and Heavy-Duty Engines and Vehicles (Phase 1)	<i>Regulation</i>	Establishes GHG standards for new medium- and heavy-duty engines and vehicles sold in California, beginning with model year 2014. California's Phase 1 regulation harmonizes with the federal phase 1 standards.
22 Greenhouse Gas Regulations for Medium- and Heavy-Duty Engines and Vehicles (Phase 2)	<i>Regulation</i>	Expands the scope and stringency of the GHG regulations established in the Phase 1 regulations and are applicable starting with the 2021 model year for engines and vehicles.
23 Greenhouse Gas Vehicle Regulations ("Pavley" regulations)	<i>Regulation</i>	Establishes GHG standards beginning with 2009 model year light-duty vehicles and medium-duty passenger vehicles and added various GHGs to the emissions that the State was regulating.
24 Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)	<i>Incentive</i>	Funds vouchers to reduce the cost of hybrid and zero-emission trucks and buses at the time of purchase.
25 Innovative Clean Transit Regulation	<i>Regulation</i>	Requires transit agencies to purchase increasing percentages of new zero-emission buses, with 100 percent of new buses purchased being zero-emission by 2029.
26 Low Carbon Fuel Standard (LCFS)	<i>Regulation</i>	Sets carbon intensity standards for transportation fuels in California. LCFS uses a system of tradeable credits to determine compliance. Fuel producers must comply with the regulation either by producing or buying lower carbon-intensity fuels, lowering their fuels' carbon intensity, or buying credits from other producers.
27 Low-Emission Vehicle Program III (LEV III) Greenhouse Gas Regulations	<i>Regulation</i>	Establishes GHG standards for multiple kinds of emissions for 2017 and subsequent model year light-duty vehicles and medium-duty passenger vehicles.
28 Lower-Emission School Bus Program	<i>Incentive</i>	Funds the purchase of new buses to replace old, high-emission public school buses and to equip in-use diesel school buses with retrofit devices that significantly reduce certain toxic emissions.

PROGRAM NAME	TYPE	DESCRIPTION
29 Ocean-Going Vessels at Berth Regulation	Regulation	Requires fleets to reduce their auxiliary engine power usage or equivalent emissions when at berth at regulated ports within California.
30 Optional Low-NOx Standards for Heavy-Duty Engines	Regulation	Establishes optional low-NOx emission standards for heavy-duty engines. Manufacturers can certify engines to these standards or to an existing mandatory standard.
31 Outreach, Community Transportation Needs Assessments, Technical Assistance, and the One-Stop-Shop	Incentive	Provides funding and technical assistance to community-based organizations for outreach on other sources of funding, conducting community transportation needs assessments, strengthening partnerships, developing projects, and applying for CARB's clean transportation incentive projects.
32 Rural School Bus Project	Incentive	Funds zero-emission school buses and new school buses that use renewable fuels. It prioritizes older school buses with higher mileage in small- and medium-sized air districts.
33 Sustainable Communities	Land Use and Transportation Planning	Establishes regional GHG emission targets for each metropolitan planning organization (MPO) in the State. The MPOs are required to develop a Sustainable Community Strategy that shows how the region could meet CARB's GHG emissions reduction targets.
34 Sustainable Transportation Equity Project (STEP)	Incentive	Grants funding to support planning and capacity-building efforts in communities in order to prepare those communities to implement clean transportation and land-use projects. STEP additionally provides grants intended to increase community residents' access to and use of their mobility system so they can get where they need to go without the use of a personal vehicle.
35 Tire Inflation Regulation	Regulation	Requires automotive service providers to perform a tire pressure service on all passenger cars, light-duty trucks, medium-duty vehicles, and light heavy-duty vehicles while performing any vehicle maintenance or repair service.
36 Tractor-Trailer Greenhouse Gas Regulation	Regulation	Requires certain types and sizes of trailers and their tractors used for long-distance goods movement to have aerodynamic equipment and low rolling resistance tires when traveling in California.
37 Truck and Bus Regulation	Regulation	Requires emissions control equipment retrofit for certain trucks and buses and accelerates the turnover of older trucks and buses.
38 Volkswagen Environmental Mitigation Trust	Oversight	CARB is the lead agency implementing California's allocation of this trust, which includes developing a plan that describes the State's goals for the use of the funds, the categories of what can be funded, and the percentages of funds to be allocated to the categories.
39 Zero- and Near Zero-Emission Freight Facility Project	Incentive	Funds a variety of heavy-duty vehicles, off-road equipment, and fueling infrastructure, as well as other facility and efficiency improvements to reduce emissions facilitywide. Freight facilities include warehouses, distribution centers, seaports, and freight airports, among others.
40 Zero-Emission Airport Shuttle Regulation	Regulation	Requires airport shuttle operators to transition to 100 percent zero-emission vehicle technology by 2035.
41 Zero-Emission Drayage Truck Pilot	Incentive	Funds a large-scale deployment of zero-emission trucks that can operate in drayage or regional haul service.
42 Zero-Emission Powertrain Certification Regulation	Regulation	Establishes an optional certification pathway that manufacturers can use to certify their heavy-duty electric and fuel-cell vehicles and is intended to help reduce variability in the quality and reliability of heavy-duty zero-emission technology, among other things.
43 Zero-Emission Truck and Bus Pilot Projects	Incentive	Funds competitively awarded projects intended to complement HVIP by supporting larger-scale deployments of zero-emission vehicles.
44 Zero-Emission Vehicle Regulation (ZEV)	Regulation	Requires auto manufacturers to produce a certain amount of ZEVs each year to meet credit requirements established by the regulation. The manufacturer's credit requirement is a percentage of their total annual passenger car and light-duty truck sales in the State.

Source: CARB's management, regulatory documents, funding plans, reports, and documents provided to the Legislature and state law.

Note: CARB has identified that some programs have a primary goal of reducing GHGs while others reduce GHG emissions as a "co-benefit" to other emissions reductions.

Appendix B

Scope and Methodology

The Audit Committee directed the State Auditor to conduct an audit of CARB to determine the effectiveness of its oversight of GHG reduction programs related to transportation. Table B lists the objectives that the Audit Committee approved and the methods we used to address them.

Table B
Audit Objectives and the Methods Used to Address Them

AUDIT OBJECTIVE	METHOD
1 Review and evaluate the laws, rules, and regulations significant to the audit.	Reviewed relevant state laws and regulations related to GHG reduction and transportation programs.
2 Identify the number and type of CARB's GHG emissions reduction programs in the transportation sector.	Reviewed a list of programs CARB has created; reviewed program descriptions in CARB's annual funding plans and its website; interviewed CARB staff.
3 Determine the extent to which CARB's programs overlap and how they may interact with one another.	<ul style="list-style-type: none"> • Identified transportation-related objectives in CARB's 2017 scoping plan and selected 19 programs for review based on vehicle type and transportation sector objective, program type, and potential for overlap. • For the selected groups of programs that work toward shared objectives in CARB's 2017 scoping plan, we reviewed CARB's documentation justifying the development of each program and interviewed CARB officials to determine the extent to which CARB identified and addressed overlap among the programs. • Our consultant assessed the programs' design and CARB's measurement of the programs' benefits to assess whether CARB accounted for any overlap.
<p>4 For a selection of CARB's GHG emissions reduction programs in the transportation sector, identify the following:</p> <p>a. Whether CARB assesses the effects of the programs on communities and households after it has implemented those programs. Assess, to the extent possible, how each program has affected households and communities, including those of different economic status, ethnicities, and locations throughout California.</p>	<ul style="list-style-type: none"> • Reviewed CARB's program data on spending in disadvantaged and low-income communities to ensure that spending was appropriately categorized. • Reviewed CARB's underlying program data and information in CARB's funding plans and annual reports, and interviewed CARB staff to identify the specific socioeconomic benefits it intends its programs to provide to participants and their households, including financial and employment benefits. Determined the extent to which CARB measures and reports on those benefits.

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AUDIT OBJECTIVE	METHOD
<p>b. The annual GHG emission reductions that result from each program and whether those reductions result from moving emissions rather than eliminating them.</p> <p>c. The programs' cost-effectiveness, including social benefits and costs, and compare them to other GHG emissions reduction programs, such as the cap-and-trade program.</p> <p>d. To the extent possible, the number of program participants who may have changed their behavior without the program and whether CARB's strategies to reduce the occurrence of this issue have been successful.</p> <p>e. To the extent possible, whether the programs' activities have contributed to the development of a diverse and equitable workforce in the affected industries.</p>	<ul style="list-style-type: none"> • Assessed the extent to which CARB reports on the GHG emissions reductions that result from its transportation programs. • Reviewed the underlying data and assessed CARB's processes for collecting and compiling those data to assess the completeness of CARB's reporting on emissions reductions. • With our consultant's assistance, assessed the reasonableness of CARB's methods for projecting emissions reductions and for estimating actual reductions from each program. Reviewed emissions estimates for its most recent annual report to determine whether CARB calculated those data accurately and consistently. • As part of our review of CARB's regulatory programs, our consultant assessed the risk that projected emissions reductions may be achieved by merely shifting those emissions elsewhere. • Reviewed and verified the total program expenditures in CARB's annual reports for a selection of programs. Compared the cost information to the GHG reduction information we reviewed in Objective 4b. • Assessed select incentive programs' relative costs in the context of our review of socioeconomic benefits under Objective 4a. <p>For the 10 incentive programs we reviewed, interviewed CARB staff and assessed their data collection mechanisms, such as surveys, for each program to determine if they collect information on behavioral changes and, if so, how they have used the information.</p> <p>For incentive programs we reviewed, particularly pilot programs targeted at specific industries, evaluated CARB's approach to setting job creation goals and job training goals, and evaluated its data collection and reporting.</p>
<p>5 Assess the process CARB uses to create initial statements of reasons for proposing new GHG reduction programs in the transportation sector, including the following:</p> <p>a. How it considers effects of a program on air quality, the environment, administrative costs, the overall economy, and low-income and disadvantaged communities.</p>	<ul style="list-style-type: none"> • For the eight regulatory programs we reviewed, assessed CARB's <i>initial statements of reasons</i>—the documentation that CARB is required to publish when proposing regulatory programs that set forth the rationale for CARB's determinations that the adopted, amended, or repealed regulations are reasonably necessary and that are prepared in a manner consistent with the environmental purposes of CARB's regulatory activity—as well as selected regulations. • Assessed the contents of this documentation against selected key criteria in the Administrative Procedures Act (APA) governing the regulation development process. The programs we reviewed complied with the selected key requirements in law. • Reviewed the initial statements of reasons and supporting documentation, and interviewed CARB staff, to determine the extent to which CARB considered the effects of the regulations on air quality, the environment, administrative costs, the overall economy, and low-income and disadvantaged communities. • For the 10 incentive programs we reviewed that CARB did not establish through regulation, reviewed documentation related to the design, implementation, and funding of the programs, and interviewed CARB staff to determine the extent to which CARB considered the effects of the programs on air quality, the environment, administrative costs, the overall economy, and low-income and disadvantaged communities. • As described under Objective 4b, our consultant also reviewed CARB's projected emissions reduction methodologies for regulatory and incentive programs.

AUDIT OBJECTIVE	METHOD
<p>b. How it considers potential interactions and effects with existing policies and programs.</p>	<ul style="list-style-type: none"> - Reviewed selected regulations, the initial statements of reasons for the eight regulatory programs and relevant documentation for the 10 incentive programs we reviewed, and interviewed CARB staff to assess whether and how CARB considers interactions with other programs when proposing new programs. - Our consultant reviewed whether CARB's program design accounts for potential interactions as a part of the work under Objective 3.
<p>6 Assess whether changes to GHG emissions reduction programs in the transportation sector should be addressed through changes to state law or regulation.</p>	<p>Assessed whether changes to state law or regulations were required to address issues we identified as a part of our work on the other objectives. Concluded that without improved program measurement and reporting, specific changes to existing programs in law or regulations would be premature.</p>
<p>7 Review and assess any other issues that are significant to the audit.</p>	<p>We did not identify any additional issues that are significant to the audit.</p>

Source: Analysis of Audit Committee's audit request number 2020-114, state law, and information and documentation identified in the column titled Method.

Assessment of Data Reliability

In performing this audit, we relied on electronic data obtained from CARB's California Climate Investments Reporting and Tracking System (CCIRTS) database, which CARB populates with data from its program administrators. The U.S. Government Accountability Office, whose standards we are statutorily required to follow, requires us to assess the sufficiency and appropriateness of the computer-processed information we use to support our findings, conclusions, and recommendations. To perform this assessment, we compared a selection of data from CARB's program administrators for the period from December 2015 through May 2020 to CARB's annual report to the Legislature. We identified discrepancies in the data for two of the five programs that could affect the precision of CARB's reports to the Legislature.

We also reviewed CARB's efforts to ensure that the detail in the program data is accurate, which includes formal reviews of how a program administrator carries out its duties under its cap-and-trade grant agreement. However, we found that CARB has only completed formal reviews for two of the five programs we selected for our review. Further, CARB has not formally reviewed one of those two programs since 2014, and it has retained very limited documentation from its two reviews of the other.

Although our findings raise questions about the reliability of some of the data CARB reports to the Legislature, we disclose these issues in our report and make recommendations to CARB to address them. Furthermore, our overall conclusion about CARB's program measurement is that CARB should make improvements that go beyond the validity of the program data itself. For these reasons, although the issues we identified above may affect the precision of some of the numbers we report, there is sufficient evidence in total to support our findings, conclusions, and recommendations.



Gavin Newsom, Governor
Jared Blumenfeld, CalEPA Secretary
Liane M. Randolph, Chair

February 3, 2021

Elaine M. Howle, CPA*
California State Auditor
621 Capitol Mall Suite 1200
Sacramento, California 95814
[submitted via electronics link as directed]

Dear Ms. Howle,

Thank you for the opportunity to review the draft Report 2020-114 *California Air Resources Board: Improved Program Measurement Would Help California Work More Strategically to Meet Its Climate Change Goals*. The California Air Resources Board (CARB) appreciates the time that your staff has spent with us over the last year to develop the recommendations.

CARB has already started implementing a number of steps to address these recommendations and will be taking future steps as described in the attachment consistent with direction from the Legislature. In the case of some recommendations, it will take time to work through the public process to determine the most efficient and effective mechanisms to collect and analyze the additional data and information that you are recommending, and we are committed to doing so. I also want to note that implementing a number of the recommendations will likely come with an assessment that additional staffing and resources will be needed to fulfill CARB's ability to deliver them.

You will find attached a more detailed response on how CARB will address the recommendations included in the report.

CARB looks forward to working with your team to track our progress implementing these recommendations and to share that information with the public and the Legislature. If you have any questions, please contact me at (916) 322-7077.

Sincerely,

A handwritten signature in black ink, appearing to read "R. W. Corey", with a checkmark at the end.

Richard W. Corey, Executive Officer

Attachment

* California State Auditor's comments begin on page 73.

Attachment
California Air Resources Board (CARB) Responses to California State Auditor
Recommendations in Draft Report
California Air Resources Board: Improved Program Measurement Would Help California
Work More Strategically to Meet Its Climate Change Goals

Recommendations from Chapter 1

RECOMMENDATION: To improve its ability to isolate each of its incentive programs' additional GHG reductions, by February 2022 CARB should establish a process to formally identify its incentive programs' overlap with other programs that share the same objectives. As part of that process, CARB should document how it will attempt to account for the overlap to allow the most accurate program measurement possible.

① CARB RESPONSE: CARB will undertake a process to better document the interaction between incentive and regulatory programs and how to refine methods to better account for emission reductions from incentives going forward. CARB will evaluate seeking funding to commission a study to determine where refinements may be needed to our quantification methodologies.

② We would like to clarify that, for purposes of tracking progress in meeting health protective federally mandated clean air laws, tools such as EMFAC (which CARB uses to assess emissions levels from specific mobile sources) account for the complementary nature of policies that may impact those sources and avoid overestimating emissions benefits.

RECOMMENDATION: As part of its work to measure both incentive and regulatory programs' additional GHG reductions, by February 2022 CARB should begin collecting and analyzing the data it needs to assess the extent to which the requirements in its regulatory programs are being exceeded by manufacturers. To the extent applicable, that analysis should focus on the components of the requirements that overlap with CARB's incentive programs, such as the extent to which manufacturers comply with regulations for heavy-duty vehicles via low- and zero-emission vehicles.

CARB RESPONSE: CARB will include the extent to which regulated parties are exceeding regulatory requirements as we consider how to implement the preceding recommendation.

RECOMMENDATION: To improve its ability to identify the effectiveness of each of its incentive programs in reducing GHG emissions, by August 2021 CARB should develop a process to define, collect, and evaluate data on the behavioral changes that result from each of its incentive programs. Having done so, by February 2022 CARB should collect and analyze relevant survey information for all consumer-focused incentive programs, as well as

information about the behavioral effects of programs that other entities offer, such as the federal tax credit.

CARB RESPONSE: CARB has work underway that will help address this recommendation. CARB will also seek public input regarding additional options for conducting this work as a part of the FY 2021-22 Funding Plan for its Low Carbon Transportation incentives including seeking public input around which incentive programs are most suited for additional analysis. CARB currently has work underway that will help with this effort through surveys of participants in projects such as the Clean Vehicle Rebate Project (CVRP), Clean Cars 4 All, Car Sharing, Financing Assistance, and Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) among others. ③

CARB has also contracted with UC Berkeley to develop an evaluation model/process for CARB to use as a new standard for assessing the effectiveness, sustainability and outcomes of CARB's clean mobility equity pilot projects for disadvantaged communities and low-income communities. Researchers will identify both community-preferred and research-preferred metrics and evaluation methodologies that can be consistently applied across CARB's clean transportation equity projects. The study will also result in policy recommendations on successful project elements to inform future transportation equity funding. Results of the UC Berkeley study are expected starting in May 2022. ④

RECOMMENDATION: To better assist the State in achieving its GHG goals, CARB should use the information we describe above to refine its GHG emissions estimates for its incentive programs in its annual reports to the Legislature, the funding plans approved by its board, and any longer-term planning documents or reports.

CARB RESPONSE: As new data become available through CARB's implementation of the recommendations in this report, we will use those data to update our GHG quantification methodologies. CARB routinely evaluates and updates the quantification methodologies used to calculate the GHG emission reductions from its incentive programs as new information becomes available, and we will incorporate relevant information obtained through the recommendations in that existing process. CARB uses a public process to update these estimates and publishes the approved California Climate Investments quantification methodologies on its website after a public review period. CARB will use these updated quantification methodologies as it prepares future annual Funding Plans, annual reports to the Legislature on California Climate Investments, and other longer-term planning documents. ⑤

RECOMMENDATION: To promote transparency and inform stakeholders, beginning in December 2021, CARB should prepare an annual report for its board and the Legislature on its progress in isolating the GHG emissions reductions attributable to each of its regulatory and incentive programs. As a part of this report, CARB should identify any measurement challenges that persist and highlight any administrative barriers that prevent it from obtaining the information it needs to perform better analysis.

CARB RESPONSE: CARB will report annually on its progress in identifying GHG emission reductions from related transportation incentive and regulatory programs.

RECOMMENDATION: To strengthen the accuracy and integrity of its emissions reduction reporting, CARB should immediately begin retaining all supporting documentation it uses to perform calculations of GHG reductions for its cap-and-trade-funded incentive programs for a period of at least five years. In conjunction with this change, CARB should also document the justification for any instances in which the underlying data it uses to compile its annual reports vary from the information it publishes in those reports.

CARB RESPONSE: CARB is updating its policies and procedures for the various incentives programs it administers to secure additional data related to data reporting and associated records retention.

RECOMMENDATION: To better ensure the accuracy of its program data, by August 2021, CARB should develop a formal schedule and procedures for reviewing the supporting documentation maintained by its program administrators. These procedures, which CARB should begin using with the 2022 annual report, should specify a minimum number of records to review in relation to the program's size, should specify how staff will collect and maintain evidence to support conclusions, and should be standardized across all of CARB's incentive programs.

- ⑥ CARB RESPONSE: CARB currently conducts program and desk reviews of its program administrators. In response to this recommendation, CARB will evaluate the need for additional resources and funding to increase the frequency of its reviews and pursue opportunities to standardize that approach.

RECOMMENDATION: To ensure that the State is positioned to assess the status of its sustainable communities program, by April 2021 CARB should report to the Legislature whether it will have a usable source for measuring regional GHG emissions in time for the 2022 report. If CARB believes it may not, it should identify any administrative or bureaucratic barriers it faces in accessing data it needs for the estimates and request relevant action by the Legislature to make those data available.

CARB RESPONSE: The auditor correctly points out that CARB was unable to find a data source to accurately report GHG emissions reductions or vehicle miles travelled (VMT) by region to track SB 375 implementation. Since the 2018 progress report, CARB has initiated a number of efforts to better measure and track SB 375 program progress at a regional level. CARB will provide a status report of this work, including any issues we identify, by April 2021.

Recommendations from Chapter 2

RECOMMENDATION: To ensure that it communicates clearly to the Legislature about the extent to which programs benefit low-income households as the Legislature intended, by

March 2022 CARB should begin reporting its spending in low-income communities at the household level wherever possible in its annual report to the Legislature.

CARB RESPONSE: CARB currently implements three incentive projects where participation is limited by household income – Clean Cars 4 All, CVRP, and Financing Assistance for Lower-Income Consumers. CARB collects household income information from participants in each of these projects. As of the most recent California Climate Investments reporting cycle, CARB now reports low-income benefits into the California Climate Investments Reporting and Tracking System (CCIRTS) at the household level for all three of these projects. In response to this recommendation, CARB will continue to report low-income benefits at the household level for all future reporting cycles for these projects and for any new projects where consumer participation is limited by household income. ⑦ ⑧

RECOMMENDATION: To better define incentive programs’ impacts beyond GHG emissions reductions, by August 2021 CARB should review its incentive programs to ensure that it has clearly designated which programs focus primarily on socioeconomic benefits. As a result of this process, by February 2022 it should ensure that it includes the benefits expected for each program in its funding plan or other public documents, such as its annual report and individual grant agreements.

CARB RESPONSE: In response to this recommendation, CARB will clarify which Low Carbon Transportation incentive programs provide socioeconomic benefits, including but not limited to public health benefits, green economic opportunities, and greater access to zero emission mobility. CARB’s Low Carbon Transportation equity projects authorized under Health and Safety Code Section 44258.4 (4)(A) are the projects which primarily focus on providing socioeconomic benefits. ⑨

CARB considers funding additional projects in each Funding Plan and through a public process, and will consider socioeconomic factors in the development of those projects consistent with direction from the Legislature in its budget appropriations.

RECOMMENDATION: To better demonstrate the socioeconomic benefits that its incentive programs achieve, by February 2022 CARB should do the following:

- Identify clear and measurable metrics it will use to assess each of the socioeconomic benefits it intends its programs to achieve.
- Develop a process to collect data, or use existing data, to measure and report on each metric.
- In its funding plans and annual reports, CARB should report to the Legislature and its board on the metrics.

CARB RESPONSE: In response to this recommendation CARB will work through the public process and with current project grantees, to identify additional socioeconomic metrics associated with clean transportation equity. CARB’s clean transportation equity

- ⑩ projects currently incorporate surveys, focus groups, vehicle telematics, and other means of documenting overall project effectiveness, the results of which are used to adaptively manage the projects, address users’ needs, and increase community participation, while also informing future project planning. CARB will evaluate the need to modify future grant solicitations to accommodate relevant additional metrics. The ongoing CARB contracted research by UC Berkeley will provide input to inform this effort.
- ④ Implementation of this recommendation may include an evaluation of the need for additional resources.

RECOMMENDATION: To provide transparency to the Legislature and other stakeholders, beginning in 2022, using the metrics and data described above, CARB should make funding and design recommendations in its funding plans and annual reports based on which programs are effective in producing socioeconomic benefits and at what cost.

CARB RESPONSE: In response to this recommendation and in accordance with the activities taken under the preceding recommendation, CARB will present its initial findings in the FY 2022-23 Low Carbon Transportation Funding Plan and will continue to report in future annual Funding Plans and annual reports.

RECOMMENDATION: To ensure that the State has reliable information about the extent to which cap-and-trade-funded programs create and support jobs, by August 2021 CARB should begin collecting data on the jobs produced by each of its incentive programs. Where needed, CARB should pursue amendments to its agreements with its program administrators to make reporting this information mandatory. CARB should include an analysis of these jobs data in its annual reports to the Legislature beginning in 2022.

- ⑨ CARB RESPONSE: CARB will work with its grantees for ongoing Low Carbon Transportation projects to collect and report on the direct jobs for each grantee resulting from CARB California Climate Investments funding to the maximum extent feasible. We will work with grantees to revise existing grant agreements where feasible to ensure refined reporting across programs. CARB currently reports on these jobs benefits for the FARMER Program and Community Air Protection Program in the annual California Climate Investments Report.
- ⑪

RECOMMENDATION: To ensure that its incentive programs promote effective and equitable job training, by August 2021 CARB should develop a process to assess which programs should include a job training element. For those programs it identifies, by February 2022 CARB should direct its staff or its external program administrators to collect and report on the quality of job trainings and outcomes experienced by participants, including who received training, the credentials participants received as a result, any actual or expected wages they received as a result of participating in the training or for developing the relevant expertise, and the number of participants from disadvantaged communities or low-income communities and households.

CARB RESPONSE: In response to this recommendation, CARB will seek stakeholder input as part of the annual Low Carbon Transportation Funding Plan process, to determine which programs should include a job training element. Currently, job training and workforce training elements have been included in some clean transportation equity projects and heavy-duty demonstration and pilot projects. For projects identified through the annual Funding Plan process as being appropriate to include a job training element, CARB will ensure that grant amendments include the appropriate reporting provisions as noted in the recommendation. ⑨

Recommendation from Other Areas Reviewed

RECOMMENDATION: To ensure that it can account for the total costs of its transportation programs, beginning with fiscal year 2021-22 CARB should develop and implement processes to track the administrative costs it incurs to operate each of its transportation programs. After doing so, it should begin including those costs as part of the cost-effectiveness measurements in its annual reports to the Legislature.

CARB RESPONSE: CARB will develop and implement processes to track the administrative costs it incurs to operate each of its transportation programs within FISCAL and track those costs as part of the cost-effectiveness measurements in its annual reports to the Legislature.

Comments

CALIFORNIA STATE AUDITOR’S COMMENTS ON THE RESPONSE FROM THE CALIFORNIA AIR RESOURCES BOARD

To provide clarity and perspective, we are commenting on CARB’s response to our audit. The numbers below correspond to the numbers we have placed in the margin of CARB’s response.

We do not understand the rationale for CARB’s statement that it will evaluate seeking funding to commission a study to determine where refinements may be needed to its quantification methodologies. As we discuss throughout Chapter 1, we identified deficiencies with CARB’s methodologies—such as not accounting for overlap between its incentive and regulatory programs—that lead it to overstate those programs’ GHG emissions reductions. Therefore, CARB’s proposed study seems unnecessary given the deficiencies we already identified, and could delay CARB’s implementation of our recommendation.

①

CARB’s response conflates *statewide* emissions reporting and its Emission Factor (EMFAC) tool with its measurement of the GHG reductions achieved by its *individual* transportation programs. During our audit, CARB confirmed that the statewide emissions reductions in CARB’s reporting cannot be attributed to specific programs. The statewide reporting is designed to measure total GHG emissions, but it is not able to assign responsibility for those reductions to individual programs. Further, CARB cannot use the tool to identify or account for overlap in the GHG reductions it projects or reports for each of its transportation programs. Therefore, we stand by our recommendation on page 38.

②

Although CARB states that it currently has work underway through surveys to help address this recommendation, our review found that its surveys generally did not address the crucial question of whether participants would have purchased their vehicles without receiving an incentive. Specifically, as we discuss on page 24 and show in Table 1 on page 25, for five programs we reviewed in which CARB provides an incentive payment or other financial assistance to consumers who purchase a low- or zero-emission vehicle—Clean Cars 4 All, CVRP, Financing Assistance, FARMER, and HVIP—CARB only collects survey information about behavior changes for CVRP. Further, we explain on page 29 that of the four follow-up surveys CARB has collected for its car-sharing pilot program, only two contained questions that CARB could use to validate its GHG emissions reduction assumptions about consumers replacing trips in conventional cars. Therefore, as we recommend on pages 38 and 39, CARB should collect and analyze relevant

③

survey information for all consumer-focused incentive programs to improve its ability to identify the effectiveness of each of its incentive programs in reducing GHG emissions.

- ④ We acknowledge CARB's contract with UC Berkeley for program evaluation on pages 29 and 46 of the audit report. However, the contract with UC Berkeley includes an evaluation of a small subset of CARB's programs and notably does not include an evaluation of either HVIP or CVRP—two of CARB's largest incentive programs; it will therefore exclude relevant analysis of the majority of CARB's programs. Moreover, CARB's response indicates that results of the UC Berkeley study are expected starting in May 2022, putting those results several months after the completion date of February 2022, which we believe is reasonable to implement our recommendation. Given how crucial participant behavior is to improving CARB's emissions reduction methodologies, we believe that CARB should take the necessary actions to address our recommendation fully and timely.
- ⑤ As we state above in comment 1, we identified deficiencies with CARB's quantification methodologies—such as not accounting for overlap between its incentive and regulatory programs—that lead it to overstate those programs' GHG emissions reductions. Therefore, as we conclude on page 20, the processes CARB describes in its response have not done enough to demonstrate the amount of GHG reductions it projects and measures for its incentive programs. As such, our recommendations on pages 38 and 39 reflect our belief that CARB should be proactive in collecting and evaluating the information it needs to better measure programs' emissions benefits—including information we already identified and named.
- ⑥ CARB's statement that it currently conducts program and desk reviews of its program administrators overstates its efforts in this area. As we note on page 36, CARB has completed desk reviews for only two of the five programs we reviewed that make incentive payments to consumers—HVIP and CVRP. Further, as we state on page 37, CARB has not conducted any desk reviews for HVIP since 2014, and has conducted only two reviews for CVRP—in 2014 and 2020. Finally, we conclude on page 37 that the documentation CARB maintained from the reviews was not sufficient for us to independently determine whether any issues the reviews identified would affect emissions reporting for the programs. The shortcomings of CARB's current approach are the basis for our recommendation on page 39 that CARB develop a formal schedule for these reviews, specify how staff will collect and maintain evidence to support conclusions, and standardize the review process across all of CARB's incentive programs.

To fully implement our recommendation, CARB will need to broaden its planned implementation. Our recommendation on page 53 states that CARB should begin reporting its spending in low-income communities at the household level wherever possible in its annual report, and not solely for the three incentive programs where participation is limited by household income as CARB's response states. As we state on page 43, the Legislature has acknowledged that some of the best GHG reduction strategies are those that benefit low-income households directly, regardless of where those households are located. Therefore, our recommendation is relevant to any CARB program that provides incentive payments at the household or individual level.

⑦

Although CARB may have already begun collecting low-income household data for the Clean Cars 4 All, CVRP, and Financing Assistance programs, this data will not become public until March 2021, when it provides its next annual report to the Legislature. CARB uses the CCIRTS database it mentions in its response to collect data on individual programs for its annual reports. CCIRTS is not itself a report. As such, the activity CARB describes in its response when saying it now reports this information into CCIRTS does not satisfy the recommendation we make on page 53 to publicly report on this information. Therefore, at the point CARB publishes its next annual report, we will evaluate the report to assess CARB's implementation of this recommendation.

⑧

Although most of the incentive programs we reviewed, including CVRP and HVIP, are currently funded under the Low Carbon Transportation portion of the cap-and-trade program, our recommendations related to program information and benefits are not limited only to these programs. Rather, our recommendations apply to all of CARB's transportation programs that target GHG emissions reductions and that may have socioeconomic benefits, or to which cap-and-trade reporting guidelines apply.

⑨

CARB's characterization of its efforts to evaluate the socioeconomic benefits of its programs is disingenuous. In fact, as we discuss on page 45, CARB does not consistently collect data to determine whether its equity programs actually provide the socioeconomic benefits CARB intends. In an example we discuss on page 45, the metrics CARB identified for its Financing Assistance program do not allow it to measure the benefits it intends the program to provide. Further, despite repeatedly citing participants' loan repayment rates as a measure of the Financing Assistance program's success in its annual funding plans, CARB does not collect data about or report on these rates. As we explain on page 46, CARB also does not consistently use the data that are available to demonstrate benefits from programs and determine whether the

⑩

programs are achieving their goals. Finally, managers for both the Financing Assistance and Clean Cars 4 All programs confirmed that CARB has not made any changes to the programs based on the data provided by program administrators in quarterly reports to CARB. Therefore, we do not agree with CARB's assertion that it incorporates these types of data to manage the programs and inform future planning.

⑪

CARB's statements are not fully responsive to our recommendation on page 53, which states that CARB should begin collecting data on the jobs produced by each of its incentive programs. We explain on page 50 that CARB's own 2015 guidelines state that it should track and report the number of job recipients and trainees funded by its programs. As a result, CARB should already be collecting and reporting on this information. Further, as we state on page 51, CARB could seek to amend its grant agreements or, failing that, use its own tool to determine jobs benefits rather than relying on its program administrators to do so. Therefore, CARB should pursue any or all of these reasonable steps to fulfill its own reporting requirements. Finally, although CARB asserts that it reports jobs benefits for the FARMER and Community Air Protection programs, as we discuss on page 50, in its most recent annual report to the Legislature in March 2020, CARB had not reported any job creation numbers for individual programs. Instead, CARB reported aggregate job numbers across all cap-and-trade funded programs across multiple agencies. Further, those aggregate numbers were incomplete because, of the nine programs we reviewed for which jobs reporting requirements apply, CARB had collected jobs data in its reporting database for only three at the time of our review.

Thank you for your comment. We have referenced the content of your comment and the cited research in the Introduction of Appendix 1. Discussion on reinterpretation of data should be directed to the governing agency (i.e., EPA, CARB) that handles the specific concern. South Coast AQMD is responsible for reporting the current research and implementing control measures for limits set by the governing agency.

Comment Letter #82

From: Natalie Hernandez <hernandez.nataliemarie@gmail.com>

Sent: Wednesday, August 10, 2022 12:47 AM

To: Sang-Mi Lee <slee@aqmd.gov>

Cc: AQMP Team <AQMPTeam@aqmd.gov>; Sarah Rees <SRees@aqmd.gov>; Ian MacMillan <imacmillan@aqmd.gov>

Subject: Re: South Coast AQMD Advisory Council Meeting

Hello Sang-Mi Lee,

Here are my written comments.

- The health analysis is very thorough.
- I appreciate the detailed studies on impacts to children in schools and those in low-income areas. My mom for a long time taught at an elementary school in West Long Beach near polluting sites, and I saw the impact bad air days had on her and her students.
- As representative of a climate change organization, [Climate Resolve](#), I am curious why air pollution during extreme heat days over 95 degrees was not referenced in the analysis? In the short-term, it could be included in the last "Recent Research and Upcoming Topics". Here are two related articles on the topic: [When Heat Waves Meet Air Pollution, Death Risks Rise Substantially](#) and [Dual Impacts of Extreme Heat, Ozone Disproportionately Hurt Poorer Areas](#). In the long-term, I hope the topic would be included more throughout the report.
- Continue to keep Wildfire and COVID-19 as recent research and upcoming topics as well.

Thank you,

Natalie M. Hernandez

LinkedIn: www.linkedin.com/in/nataliemhernandez

Thank you for your comments and suggestions. Per your suggestion we have included the papers you mentioned as well as others in a section on extreme heat and its interaction with air pollution and impacts on human health. You will find this included in the Emerging Research Section. We have also expanded the sections on wildfires and COVID-19.

Comment Letter #83

From: Jo Kay Ghosh <jghosh@helunahealth.org>

Date: August 11, 2022 at 7:05:07 PM PDT

To: Sang-Mi Lee <slee@aqmd.gov>

Subject: Comments on AQMP Appendix I Health Effects

Dear Sang-Mi,

Please find my comment letter attached. If you have any questions, please feel free to reach out to me.

Thanks,

Jo Kay

Jo Kay Ghosh, PhD, MPH (*she/her*)

Director of Research and Evaluation

Heluna Health

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August 11, 2022

Submitted via email

Dr. Sang-Mi Lee
Planning and Rules Manager
South Coast Air Quality Management District
slee@aqmd.gov

RE: Comments on the draft 2022 AQMP Appendix I: health effects

Dear Dr. Lee:

Thank you for the opportunity to submit comments on the draft 2022 AQMP Appendix I and for the Advisory Council discussion on August 10.

Overall, the 2022 AQMP draft Appendix I (Health Effects) appropriately summarizes the state of the science on the health effects of criteria air pollutants, and highlights the results of numerous studies that have been reviewed in the ISAs and some other key review papers. The summary is well-organized

and provides an appropriate level of detail for the reader to understand the studies being described. The comments provided here are intended to help improve the overall clarity of the document. Based on the discussion at the August 10 Advisory Council meeting, I look forward to seeing the results of the health benefits analysis from the Socioeconomic Report, which help to illustrate the potential health impacts of reducing these pollutants in the South Coast region.

As a general comment, although the introduction describes an effort to highlight studies conducted in southern California (or California in general), it was not clear that this was the approach taken for the appendix. Although studies from other places may be generalizable to the population in the South Coast AQMD, it is helpful and compelling to see studies conducted within the local region. These data help to reinforce that criteria air pollutants are impacting the health of residents in the South Coast. Certainly, there have been many epidemiological studies conducted in the greater Los Angeles region or in California, or even toxicology studies utilizing air samples from southern California. It would be helpful to clarify whether study location was indeed one of the factors considered when selecting which epidemiological studies to highlight in this appendix.

Thank you for your detailed comments for Appendix I. We really appreciate the time you put in responding. In regard to your general comment about focusing on California specific studies. We have tried to highlight the California specific studies in the relevant sections, but many other studies are included in the appendix as well to highlight the health endpoints in question.

Below are some detailed comments on specific sections of the draft appendix –

Ozone

- Given the length of the appendix, it would be helpful to add text to the beginning of each pollutant section to reiterate the attainment status for that pollutant.

At the beginning of each criteria pollutant section, we have included a table indicating attainment status.

- Page I-6 - Regarding EPA's downgrade of short-term ozone and cardiovascular effects from "likely" in the 2013 ISA to "suggestive" in the 2020 ISA warrants some explanation, especially since the recent studies provided on pages I-26-27 all provide additional evidence supporting such a relationship.

We have added an explanation with the supporting evidence in this section.

Although the Appendix includes some text about the new evidence indicating inconsistent results (page I-42), the studies that you summarized in that previous section does not reflect such "inconsistency".

We have added the studies that reflect the inconsistency.

- Page I-8 – In this paragraph, you cite studies that use 3-hour exposures to 70ppb or 100ppb, among other concentrations. These types of exposures do, in fact, occur routinely in the summer season in the South Coast Air Basin. Although it is true that lower ambient concentrations are more common, this paragraph should acknowledge the context of South Coast's ozone levels. Additionally, please check the FEV1 decrement cited for the Arjomandi 2018 study.

There is a sentence at the end of this paragraph that acknowledges that these exposures are common in the South Coast Air Basin. We have fixed the FEV1 decrement cited for Arjomandi et al. (2018).

- Page I-9 to I-10 - In this section's description of the results of experimental studies, the Appendix describes that the data do not show asthmatics to be a sensitive group. However, it should be noted that there are limitations to these types of human exposure studies. For example, even though some studies enroll patients with previously diagnosed asthma, people with poorly controlled asthma would unlikely be eligible for such studies. Additionally, these human exposure studies typically only enroll adults rather than children.

This point has been added in.

- Table I-3 – The table identifies pre-existing asthma as a factor that increases susceptibility to ozone-related health effects. If this wasn't found in experimental studies, was this identified in observational studies (e.g. of asthma exacerbation)? If this is the case, then the evidence supporting the identification of this susceptible population is worth discussing.

The evidence for this is included in the Appendix. The studies are discussed now in more detail.

- In general, it would be easier to interpret the OR/CI's cited in the document if you provided the exposure unit that was used (e.g. for each 10ppb increase in ozone exposure averaged over 8 hours...)

While we agree that this would help in interpreting the OR/CI's, we have included the information as is cited in the EPA ISA's. A constraint here is the time required to do so.

Particulate Matter

- Page I-44 – two of the bullets are indented and it does not seem like they should be (they are not sub-bullets of the previous bullet point). Also, the Supplement to the 2019 ISA was published in May 2022, so you should update the citation.

This has been corrected.

- Table I-4 – where are the causality determinations for cancer and mortality? These need to be added to the table.

These have been added.

- Table I-5 – the units in this table are incorrect (they should be ug/m³). Also, please use the appropriate number of significant digits based on the NAAQS (e.g. 12.0 vs 12).

This has been corrected.

- Exposure units – similar to the ozone section, it would be easier to interpret the associations cited if you provided the exposure unit that was used in the study.

Same comment as above.

- Page I-62 – there are some extra numbers in some of the sentences here.

These have been deleted.

- Cardiovascular Mortality with short-term PM exposure – I find it a little awkward that the cardiovascular mortality section is presented separately from the "Mortality" section. Could these sections be combined, or perhaps the earlier section can refer to the latter section for related information?

We have combined Cardiovascular Mortality in the Mortality section.

- UFP – it might be worth mentioning that there is no nation-wide network of monitors for UFPs, so studies rely on short-term or other special monitoring campaigns.

This has been mentioned.

Sulfur Dioxide

- In the last paragraph, it would be helpful to describe the relationship between SO₂ and sulfates.

We have included a paragraph to describe this relationship.

TACs

- I think the first sentence providing the definition of a TAC may be confusing. I recommend revising to state: “Toxic air contaminants are a group of pollutants defined in the California Health and Safety Code (section 39655) as ‘air pollutant[s] which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health.’”

We have revised to your suggested sentence.

VOCs

- Page I-137, 1st paragraph –it would be helpful to add that specific VOCs that are air toxics are also subject to air toxics regulations.

This has been included.

- Page I-137, 3rd paragraph – For the MATES V data, please specify whether the percentages cited in this paragraph are derived from the measurement or the modeling results.

We have clarified this.

- Page I-138, 2nd paragraph – while the statement that the MATES V data showed that the levels for individual pollutants were below the chronic RELs is correct, there was an exploratory analysis conducted as part of MATES V that calculated the chronic HI based on measurement data. That analysis showed that when the health effects of multiple pollutants acting on the same target organ systems are accounted for simultaneously, the hazard index is above one, indicating that the levels of air toxics in those locations could cause health effects. The results of that analysis should be cited here.

We have cited the results of this analysis.

- Page I-138, 2nd paragraph – The data comparing the reductions in air toxics cancer risk in EJ communities and non-EJ communities are based on the SB535 definition of a “disadvantaged community”. This definition should be specified, as there is no standard definition of what constitutes an environmental justice community. The 52% reduction in air toxics cancer risk in non-EJ communities – is this figure based on revised MATES V modeling results? The MATES V final report cites this number as 53%.

We have specified the definition based on SB535 and defined the basis for the percentage reduction. We have adjusted the percentage amount.

- Page I-138, 2nd paragraph – the discussion about AB 617 communities should be in a separate paragraph. The work conducted through AB 617, including the local monitoring programs implemented in the designated communities, are generally not part of the MATES program. Therefore, I recommend deleting the sentence that begins “MATES V study included local-scale studies...”. Instead, the discussion about AB 617 in this section should simply mention that the District has been implementing this law through community planning efforts as well as through BARCT and incentive program implementation.

We have made these changes and reorganized the information presented.

Conclusions

- Figure I-12 – fix the formatting issue for the 2015 box.

Recent Research and Upcoming Topics

While I agree that wildfire health impacts and potential impacts of air pollution exposures on COVID-19 outcomes are important and topical issues to address through research, the purpose of this section of the Appendix is not clear. Specifically, it is not clear why these particular studies were chosen to be highlighted when there are far more studies on these topics than the ones cited here. In particular, the Meo 2021 study has some serious methodological shortcomings and lack of clarity on their pollution exposure estimation methods. As a general comment, in the rush to publish studies related to COVID-19 outcomes, many studies utilized ecologic study designs or exposure models that do not reflect spatial variations in PM2.5 air pollution across regions. If you are to highlight studies of air pollution effects on COVID-19 outcomes, I would strongly recommend describing some limitations of those studies.

Here is one possible study to consider citing regarding air pollution and COVID-19 outcomes:

- English et al. 2022 Environ Adv. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9316717/>

We have rewritten this section including more studies and indicating the limitations of the ones mentioned.

Here are some suggested studies to consider citing regarding wildfire air pollution health effects:

- Jones et al 2020 J Am Heart Assoc. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7428528/>

- Stowell et al 2019 Environ Int <https://pubmed.ncbi.nlm.nih.gov/31520956/>

- Heaney et al 2022 Geohealth <https://pubmed.ncbi.nlm.nih.gov/35795228/>

- This review paper from 2018 can provide some additional (albeit somewhat older) references: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6697173/>

We have included the references suggested here.

I thank the AQMD staff for considering my comments and recommendations to improve the Appendix I, and I look forward to reviewing a future draft of this report.

Sincerely,

Jo Kay Ghosh
Director of Research and Evaluation
Heluna Health
jghosh@helunahealth.org

Comment Letter #84

Comments on SCAQMD 2022 draft AQMP_Appendix 1

Major comments:

1. As mentioned in the Introduction, this is “a report on the health impacts of particulate matter in the South Coast Air Basin (SCAB)”. The purpose of this document is to provide “a brief summary of the conclusions of scientific reviews conducted by U.S. EPA and other scientific agencies, with some additional information from more recently published studies”. One would expect this Appendix to focus on studies within SCAB, especially including publications from recent years (e.g., the 2019 USEPA PM Integrated Science Assessment (ISA) included literature up to the end of 2017 or before 2018, and the 2020 Ozone ISA included literature before April 2018). However, very few recent publications were included, especially in the ozone and PM sections. The individual studies that are mentioned are mostly older studies before the latest ISAs were released and didn’t necessarily focus on Southern California.

I suggest the authors put more weight on studies conducted in Southern California or other areas with similar ranges of air pollution levels, climate patterns, and population demographics. Local climate, e.g., temperature, relative humidity, and geography, may also interact with health impacts of air pollution, especially ozone. Demographic characteristics, such as racial/ethnicity and socioeconomic status, should also be considered.

Furthermore, recent literature suggests that dose-response relationships changed over time (Bi et al. 2020 <https://www.sciencedirect.com/science/article/abs/pii/S0013935120308628>; Chen et al. 2021 [https://www.thelancet.com/pdfs/journals/lanplh/PIIS2542-5196\(21\)00168-6.pdf](https://www.thelancet.com/pdfs/journals/lanplh/PIIS2542-5196(21)00168-6.pdf)), as air pollution, population demographic distributions, health service/technology all change over time, studies conducted more recently are more relevant.

There are many new articles on health effects of criteria air pollutants that have been published since 2018. Here are some papers most relevant to Southern California identified from a brief search of Scopus:

Thank you for your comment and for providing us with a list of references. Almost all have been included. The section that they are included in is indicated below. As for focusing on California specific studies, we have tried to include them in the section that is most appropriate. Other area studies are nonetheless included to highlight the health end point of concern.

- 1) Hao, H., Eckel, S.P., Hosseini, A., Van Vliet, E.D.S., Dzibur, E., Dunton, G., Chang, S.Y., Craig, K., Rocchio, R., Bastain, T., Gilliland, F., Okelo, S., Ross, M.K., Sarrafzadeh, M., Bui, A.A.T., Habre, R. Daily Associations of Air Pollution and Pediatric Asthma Risk Using the Biomedical REAI-Time Health

Evaluation (BREATHE) Kit (2022) *International Journal of Environmental Research and Public Health*, 19 (6), art. no. 3578, . Sidell, M.A., Chen, Z.,

Included in respiratory effects for short-term ozone, PM2.5, and NO exposure.

2) Ademu, L.O., Gao, J., Thompson, O.P., Ademu, L.A.

Impact of Short-Term Air Pollution on Respiratory Infections: A Time-Series Analysis of COVID-19 Cases in California during the 2020 Wildfire Season (2022) *International Journal of Environmental Research and Public Health*, 19 (9), art. no.

Included in COVID-19 section.

3) Huang, B.Z., Chow, T., Eckel, S.P., Martinez, M.P., Lurmann, F., Thomas, D.C., Gilliland, F.D., Xiang, A.H.

Ambient air pollution and COVID-19 incidence during four 2020–2021 case surges (2022) *Environmental Research*, 208, art. no. 112758, . Cited 1 time.

Included in COVID-19 section.

4) Sun, Y., Li, X., Benmarhnia, T., Chen, J.-C., Avila, C., Sacks, D.A., Chiu, V., Slezak, J., Molitor, J., Getahun, D., Wu, J. Exposure to air pollutant mixture and gestational diabetes mellitus in Southern California: Results from electronic health record data of a large pregnancy cohort (2022) *Environment International*, 158, art. no. 106888, . Cited 3 times.

Included in reproductive and developmental effects for long-term PM2.5 exposure

5) Petkus, A.J., Resnick, S.M., Wang, X., Beavers, D.P., Espeland, M.A., Gatz, M., Gruenewald, T., Millstein, J., Chui, H.C., Kaufman, J.D., Manson, J.E., Wellenius, G.A., Whitsel, E.A., Widaman, K., Younan, D., Chen, J.-C.

Ambient air pollution exposure and increasing depressive symptoms in older women: The mediating role of the prefrontal cortex and insula (2022) *Science of the Total Environment*, 823, art. no. 153642, . Cited 2 times

Included in nervous system effects for long-term PM2.5 and NO exposure.

6) Younan, D., Wang, X., Millstein, J., Petkus, A.J., Beavers, D.P., Espeland, M.A., Chui, H.C., Resnick, S.M., Gatz, M., Kaufman, J.D., Wellenius, G.A., Whitsel, E.A., Manson, J.E., Rapp, S.R., Chen, J.-C. Air quality improvement and cognitive decline in community-dwelling older women in the United States: A longitudinal cohort study (2022) *PLoS Medicine*, 19 (2), art. no. e1003893, .

Included in nervous system effects for long-term PM2.5 exposure.

7) Ailshire, J., Walsemann, K.M.

Education Differences in the Adverse Impact of PM2.5 on Incident Cognitive Impairment Among U.S. Older Adults (2021) *Journal of Alzheimer's disease : JAD*, 79 (2), pp. 615-625. Cited 4 times.

Included in nervous system effects for long-term PM2.5 exposure.

8) Chen, C., Hayden, K.M., Kaufman, J.D., Espeland, M.A., Whitsel, E.A., Serre, M.L., Vizuete, W., Orchard, T.S., Wang, X., Chui, H.C., Dalton, M.E., Chen, J.-C., Kahe, K.

Adherence to a MIND-Like Dietary Pattern, Long-Term Exposure to Fine Particulate Matter Air Pollution, and MRI-Based Measures of Brain Volume: The Women's Health Initiative Memory Study-

MRI

(2021) *Environmental Health Perspectives*, 129 (12), art. no. 127008, . Cited 2 times

Included in nervous system effects for long-term PM2.5 exposure.

- 9) Ilango, S.D., Gonzalez, K., Gallo, L., Allison, M.A., Cai, J., Isasi, C.R., Hosgood, D.H., Vasquez, P.M., Zeng, D., Mortamais, M., Gonzalez, H., Benmarhnia, T.
Long-Term Exposure to Ambient Air Pollution and Cognitive Function among Hispanic/Latino Adults in San Diego, California

(2021) *Journal of Alzheimer's Disease*, 79 (4), pp. 1489-1496. Cited 2 times

Included in nervous system effects for long-term PM2.5 and ozone exposure.

- 10) Petkus, A.J., Younan, D., Wang, X., Beavers, D.P., Espeland, M.A., Gatz, M., Gruenewald, T., Kaufman, J.D., Chui, H.C., Millstein, J., Rapp, S.R., Manson, J.E., Resnick, S.M., Wellenius, G.A., Whitsel, E.A., Widaman, K., Chen, J.-C., Zammit, A.

Associations between Air Pollution Exposure and Empirically Derived Profiles of Cognitive Performance in Older Women

(2021) *Journal of Alzheimer's Disease*, 84 (4), pp. 1691-1707.

Included in nervous system effects for long-term PM2.5 and NO exposure.

- 11) Ouidir, M., Seyve, E., Rivière, E., Bernard, J., Cheminat, M., Cortinovis, J., Ducroz, F., Dugay, F., Hulin, A., Kloog, I., Laborie, A., Launay, L., Malherbe, L., Robic, P.-Y., Schwartz, J., Siroux, V., Virga, J., Zaros, C., Charles, M.-A., Slama, R., Lepeule, J.

Maternal ambient exposure to atmospheric pollutants during pregnancy and offspring term birth weight in the nationwide ELFE cohort

(2021) *International Journal of Environmental Research and Public Health*, 18 (11), art. no. 5806, .

Included in reproductive effects for long-term PM2.5 exposure.

- 12) Mann, J.K., Lutzker, L., Holm, S.M., Margolis, H.G., Neophytou, A.M., Eisen, E.A., Costello, S., Tyner, T., Holland, N., Tindula, G., Prunicki, M., Nadeau, K., Noth, E.M., Lurmann, F., Hammond, S.K., Balmes, J.R.

Traffic-related air pollution is associated with glucose dysregulation, blood pressure, and oxidative stress in children

(2021) *Environmental Research*, 195, art. no. 110870, . Cited 9 times.

Included in metabolic effects for short- and long-term PM2.5 exposure and VOC exposure.

- 13) Toledo-Corral, C.M., Alderete, T.L., Herting, M.M., Habre, R., Peterson, A.K., Lurmann, F., Goran, M.I., Weigensberg, M.J., Gilliland, F.D.

Ambient air pollutants are associated with morning serum cortisol in overweight and obese Latino youth in Los Angeles

(2021) *Environmental Health: A Global Access Science Source*, 20 (1), art. no. 39, . Cited 1 time.

Included in nervous system effects for short-term Ozone and NO exposure.

- 14) Burnor, E., Cserbik, D., Cotter, D.L., Palmer, C.E., Ahmadi, H., Eckel, S.P., Berhane, K., McConnell, R., Chen, J.-C., Schwartz, J., Jackson, R., Herting, M.M.

Association of Outdoor Ambient Fine Particulate Matter with Intracellular White Matter

Microstructural Properties among Children

(2021) *JAMA Network Open*, 4 (12), art. no. e2138300, . Cited 3 times.

Included in nervous system effects for long-term PM2.5 exposure.

- 15) Davis, E., Malig, B., Broadwin, R., Ebisu, K., Basu, R., Gold, E.B., Qi, L., Derby, C.A., Park, S.K., Wu, X.M. Association between coarse particulate matter and inflammatory and hemostatic markers in a cohort of midlife women (2020) *Environmental Health: A Global Access Science Source*, 19 (1), art. no. 111, . Cited 1 time.

Included in cardiovascular effects for long-term PM10-2.5 exposure.

- 16) Su, P.-F., Sie, F.-C., Yang, C.-T., Mau, Y.-L., Kuo, S., Ou, H.-T. Association of ambient air pollution with cardiovascular disease risks in people with type 2 diabetes: a Bayesian spatial survival analysis (2020) *Environmental Health: A Global Access Science Source*, 19 (1), art. no. 110, . Cited 1 time.

Included in cardiovascular effects for long-term PM2.5 and SO2 exposure.

- 17) Tavallali, P., Gharibi, H., Singhal, M., Schweizer, D., Cisneros, R. A multi-pollutant model: a method suitable for studying complex relationships in environmental epidemiology (2020) *Air Quality, Atmosphere and Health*, 13 (6), pp. 645-657. Cited 4 times.

Not directly related to the topics in this appendix.

- 18) Pope, C.A., III, Coleman, N., Pond, Z.A., Burnett, R.T. Fine particulate air pollution and human mortality: 25+ years of cohort studies (2020) *Environmental Research*, 183, art. no. 108924, . Cited 112 times.

Included in cancer effects for long-term PM2.5 exposure.

- 19) Chau, K., Franklin, M., Gauderman, W.J. Satellite-derived PM2.5 composition and its differential effect on children's lung function (2020) *Remote Sensing*, 12 (6), art. no. 1028, . Cited 10 times.

Included in respiratory effects in healthy populations (lung function) for short-term PM2.5, SO2, and NO2 exposure.

- 20) Starling, A.P., Moore, B.F., Thomas, D.S.K., Peel, J.L., Zhang, W., Adgate, J.L., Magzamen, S., Martenies, S.E., Allshouse, W.B., Dabelea, D. Prenatal exposure to traffic and ambient air pollution and infant weight and adiposity: The Healthy Start study (2020) *Environmental Research*, 182, art. no. 109130, . Cited 19 times.

Referenced in reproductive and developmental health effects for long-term PM2.5 exposure.

- 21) Wyatt, L.H., Peterson, G.C.L., Wade, T.J., Neas, L.M., Rappold, A.G. The contribution of improved air quality to reduced cardiovascular mortality: Declines in socioeconomic differences over time (2020) *Environment International*, 136, art. no. 105430, . Cited 3 times.

Not directly related to this Appendix.

- 22) Petkus, A.J., Younan, D., Widaman, K., Gatz, M., Manson, J.E., Wang, X., Serre, M., Vizuete, W., Chui, H., Espeland, M.A., Resnick, S., Chen, J.-C.
Exposure to fine particulate matter and temporal dynamics of episodic memory and depressive symptoms in older women
(2020) *Environment International*, 135, art. no. 105196, . Cited 17 times.
Referenced in nervous system effects for long-term PM2.5 exposure.
- 23) Younan, D., Petkus, A.J., Widaman, K.F., Wang, X., Casanova, R., Espeland, M.A., Gatz, M., Henderson, V.W., Manson, J.E., Rapp, S.R., Sachs, B.C., Serre, M.L., Gaussoin, S.A., Barnard, R., Saldana, S., Vizuete, W., Beavers, D.P., Salinas, J.A., Chui, H.C., Resnick, S.M., Shumaker, S.A., Chen, J.-C. Particulate matter and episodic memory decline mediated by early neuroanatomic biomarkers of Alzheimer's disease (2020) *Brain*, 143 (1), pp. 289-302.
Referenced in nervous system effects for long-term PM2.5 exposure.
- 24) Ebisu, K., Malig, B., Hasheminassab, S., Sioutas, C.
Age-specific seasonal associations between acute exposure to PM2.5 sources and cardiorespiratory hospital admissions in California
(2019) *Atmospheric Environment*, 218, art. no. 117029, . Cited 7 times.
Referenced in cardiovascular effects for short-term PM2.5 exposure.
- 25) Jo, H., Eckel, S.P., Chen, J.-C., Cockburn, M., Martinez, M.P., Chow, T., Lurmann, F.W., Funk, W.E., Xiang, A.H., McConnell, R.
Gestational diabetes mellitus, prenatal air pollution exposure, and autism spectrum disorder
(2019) *Environment International*, 133, art. no. 105110, . Cited 16 times.
Included in reproductive effects for long-term ozone exposure.
- 26) Jo, H., Eckel, S.P., Wang, X., Chen, J.-C., Cockburn, M., Martinez, M.P., Chow, T., Molshatzki, N., Lurmann, F.W., Funk, W.E., Xiang, A.H., McConnell, R.
Sex-specific associations of autism spectrum disorder with residential air pollution exposure in a large Southern California pregnancy cohort
(2019) *Environmental Pollution*, 254, art. no. 113010, . Cited 24 times.
Already included.
- 27) Jo, H., Eckel, S.P., Chen, J.-C., Cockburn, M., Martinez, M.P., Chow, T., Lurmann, F., Funk, W.E., McConnell, R., Xiang, A.H.
Associations of gestational diabetes mellitus with residential air pollution exposure in a large Southern California pregnancy cohort
(2019) *Environment International*, 130, art. no. 104933, . Cited 30 times.
Included in reproductive effects for long term ozone exposure.
- 28) Schwarz, L., Bruckner, T., Ilango, S.D., Sheridan, P., Basu, R., Benmarhnia, T.
A quantile regression approach to examine fine particles, term low birth weight, and racial/ethnic disparities
(2019) *Environmental Epidemiology*, 3 (4), art. no. e060, . Cited 8 times.
Included in reproductive effects for long-term PM2.5 exposure.

- 29) Hajat, A., Diezroux, A.V., Castro-Diehl, C., Cosselman, K., Golden, S.H., Hazlehurst, M.F., Szpiro, A., Vedal, S., Kaufman, J.D.

The association between long-term air pollution and urinary catecholamines: Evidence from the multi-ethnic study of atherosclerosis

(2019) *Environmental Health Perspectives*, 127 (5), art. no. 057007, . Cited 16 times.

Included in nervous system effects for long-term PM2.5 exposure.

- 30) Enders, C., Pearson, D., Harley, K., Ebisu, K.

Exposure to coarse particulate matter during gestation and term low birthweight in California: Variation in exposure and risk across region and socioeconomic subgroup

(2019) *Science of the Total Environment*, 653, pp. 1435-1444. Cited 13 times.

Included in reproductive effects for long-term PM10 exposure.

- 31) Huang, H., Woodruff, T.J., Baer, R.J., Bangia, K., August, L.M., Jelliffe-Palowski, L.L., Padula, A.M., Sirota, M.

Investigation of association between environmental and socioeconomic factors and preterm birth in California

(2018) *Environment International*, 121, pp. 1066-1078. Cited 17 times.

Not directly related to information referenced in this Appendix.

- 32) Ebisu, K., Malig, B., Hasheminassab, S., Sioutas, C., Basu, R.

Cause-specific stillbirth and exposure to chemical constituents and sources of fine particulate matter

(2018) *Environmental Research*, 160, pp. 358-364. Cited 26 times.

Included in reproductive effects for long-term PM2.5 exposure.

- 33) Toledo-Corral, C.M., Alderete, T.L., Habre, R., Berhane, K., Lurmann, F.W., Weigensberg, M.J., Goran, M.I., Gilliland, F.D.

Effects of air pollution exposure on glucose metabolism in Los Angeles minority children

(2018) *Pediatric Obesity*, 13 (1), pp. 54-62. Cited 54 times.

Included in metabolic effects for short-term PM2.5 and NO2 exposure.

These are recent review articles published since 2018:

- 1) Yu, X., Rahman, M.M., Wang, Z., Carter, S.A., Schwartz, J., Chen, Z., Eckel, S.P., Hackman, D., Chen, J.-C., Xiang, A.H., McConnell, R. Evidence of susceptibility to autism risks associated with early life ambient air pollution: A systematic review (2022) *Environmental Research*, 208

Included in reproductive effects for long-term Ozone exposure.

- 2) Gong, C., Wang, J., Bai, Z., Rich, D.Q., Zhang, Y. Maternal exposure to ambient PM2.5 and term birth weight: A systematic review and meta-analysis of effect estimates (2022) *Science of the Total Environment*, 807

Included in reproductive effects for long-term PM2.5 exposure.

- 3) Xie, G., Sun, L., Yang, W., Wang, R., Shang, L., Yang, L., Qi, C., Xin, J., Yue, J., Chung, M.C. Maternal exposure to PM2.5 was linked to elevated risk of stillbirth (2021) *Chemosphere*, 283

Included in reproductive effects for long-term PM2.5 exposure.

- 4) Bevan, G.H., Al-Kindi, S.G., Brook, R., Rajagopalan, S. Ambient Air Pollution and Atherosclerosis: Recent Updates (2021) Current Atherosclerosis Reports, 23 (10)
Included in cardiovascular effects for long-term PM2.5 exposure.
- 5) Lee, Y.-G., Lee, P.-H., Choi, S.-M., An, M.-H., Jang, A.-S. Effects of air pollutants on airway diseases (2021) International Journal of Environmental Research and Public Health, 18 (18)
This is article discussed more of the mechanism of action of the pollutants than the health effect. It is not directly relevant to this Appendix.
- 6) Chun, H., Leung, C., Wen, S.W., McDonald, J., Shin, H.H.
Maternal exposure to air pollution and risk of autism in children: A systematic review and meta-analysis. (2020) Environmental Pollution, 256
Included in reproductive and developmental effects for long-term PM2.5 and NO exposure.
- 7) Gruzieva, O., Xu, C.-J., Yousefi, P., Relton, C., Merid, S.K., Breton, C.V., Gao, L., Volk, H.E., Feinberg, J.I., Ladd-Acosta, C., Bakulski, K., Auffray, C., Lemonnier, N., Plusquin, M., Ghantous, A., Herceg, Z., Nawrot, T.S., Pizzi, C., Richiardi, L., Rusconi, F., Vineis, P., Kogevinas, M., Felix, J.F., Duijts, L., Den Dekker, H.T., Jaddoe, V.W.V., Ruiz, J.L., Bustamante, M., Antó, J.M., Sunyer, J., Vrijheid, M., Gutzkow, K.B., Grazuleviciene, R., Hernandez-Ferrer, C., Annesi-Maesano, I., Lepeule, J., Bousquet, J., Bergström, A., Kull, I., Söderhäll, C., Kere, J., Gehring, U., Brunekreef, B., Just, A.C., Wright, R.J., Peng, C., Gold, D.R., Kloog, I., Demeo, D.L., Pershagen, G., Koppelman, G.H., London, S.J., Baccarelli, A.A., Melén, E. Prenatal particulate air pollution and DNA methylation in newborns: An epigenome-wide meta-analysis. (2019) Environmental Health Perspectives, 127 (5)
Included in reproductive and developmental effects for long-term PM2.5 exposure.
- 8) Ritz, B., Hoffmann, B., Peters, A. The effects of fine dust, ozone, and nitrogen dioxide on health (2019) Deutsches Arzteblatt International, 116 (51-52), pp. 881-886.
This review article has been included in the PM summary section.
- 9) Papadogeorgou, G., Kioumourtoglou, M.-A., Braun, D., Zanobetti, A. Low Levels of Air Pollution and Health: Effect Estimates, Methodological Challenges, and Future Directions (2019) Current environmental health reports, 6 (3), pp. 105-115.
This review article has been included in the PM summary section.
- 10) Liu, Q., Gu, X., Deng, F., Mu, L., Baccarelli, A.A., Guo, X., Wu, S. Ambient particulate air pollution and circulating C-reactive protein level: A systematic review and meta-analysis (2019) International Journal of Hygiene and Environmental Health, 222 (5), pp. 756-764
Included in cardiovascular effects for short-term and long-term PM2.5 and PM10 exposure.

Wildfire studies:

- 1) Fann, N., Alman, B., Broome, R.A., Morgan, G.G., Johnston, F.H., Pouliot, G., Rappold, A.G. The health impacts and economic value of wildland fire episodes in the U.S.: 2008–2012 (2018) Science of the Total Environment, 610-611, pp. 802-809.
This study uses models to determine economic costs and not directly related to what is included in this appendix.

- 2) Meo, S.A., Abukhalaf, A.A., Alomar, A.A., Alessa, O.M., Sami, W., Klonoff, D.C. Effect of environmental pollutants PM-2.5, carbon monoxide, and ozone on the incidence and mortality of SARS-COV-2 infection in ten wildfire affected counties in California (2021) *Science of the Total Environment*, 757, art. no. 143948.
Included already.
- 3) Aguilera, R., Corringham, T., Gershunov, A., Benmarhnia, T. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. (2021) *Nature Communications*, 12 (1)
Included in the wildfires section.
- 4) Heaney, A., Stowell, J.D., Liu, J.C., Basu, R., Marlier, M., Kinney, P. Impacts of Fine Particulate Matter From Wildfire Smoke on Respiratory and Cardiovascular Health in California. (2022) *GeoHealth*, 6 (6)
Included in the wildfires section.
- 5) Naqvi, H.R., Mutreja, G., Shakeel, A., Singh, K., Abbas, K., Naqvi, D.F., Chaudhary, A.A., Siddiqui, M.A., Gautam, A.S., Gautam, S., Naqvi, A.R. Wildfire-induced pollution and its short-term impact on COVID-19 cases and mortality in California (2022) *Gondwana Research*.
Included in the COVID-19 section.
- 6) Sharma, A., Valdes, A.C.F., Lee, Y. Impact of Wildfires on Meteorology and Air Quality (PM2.5 and O3) over Western United States during September 2017 (2022) *Atmosphere*, 13 (2), art. no. 262.
This not as focused on health impacts and thus not as relevant to this Appendix.

For each pollutant, table or figure summaries of the literature would be more straightforward and much appreciated.

Thank you for your comment. We agree that table or figure summaries of the literature for each pollutant would be helpful. Unfortunately, given the timeline of the 2022 AQMP it would be difficult to do this in a meaningful way with the large number of papers included in this report. However, staff will consider adding such a table in the future.

2. For the AQMP, it may be helpful to have an overview of the health effects of cumulative exposures to multiple pollutants by air district, since people are subject to the stress of multiple air pollutants at the same time. In Table I-7, excess cases of similar outcomes are summarized, e.g., outcomes related to asthma, associated with different pollutants. It would be helpful if these estimates are extrapolated to other pollutants.

Staff acknowledge that cumulative exposure to multiple air pollutants is an important consideration. However, the regulatory framework and the control measures developed within the 2022 AQMP are pollutant-specific for six major criteria pollutants covered under sections 108 and 109 of the Clean Air Act. This is appropriate, in that different pollutants can differ in their sources, their times and places of occurrence, the kinds of health effects they may cause, and their overall levels of health risk. Different pollutants, from the same or other sources, often occur together. Evidence from recent studies is consistent in supporting an association between a single pollutant concentrations and respiratory health

effects independent of coexposures to correlated pollutants. For example, across pollutants, single-pollutant associations reported between ozone and a range of respiratory-related hospital admissions and emergency department (ED) visits were persistent, although sometimes lessened, in copollutant models (U.S. EPA, 2020). While the combined effects of multiple air pollutants that occur simultaneously are important, single-pollutant associations still hold true. Furthermore, the air quality standards address each criteria pollutant separately. Therefore, this Appendix is divided into sections by pollutant.

Minor comments:

1. Page I-2, American Heart Association (AHA) also periodically published scientific statements based on expert review on cardiovascular effects from air pollution.

2004 review: <https://www.ahajournals.org/doi/10.1161/01.cir.0000128587.30041.c8>

2010 review: <https://www.ahajournals.org/doi/10.1161/cir.0b013e3181dbee1>

2020 review: <https://www.ahajournals.org/doi/10.1161/CIR.0000000000000931>

Since the mortality associated with PM mainly related to cardiovascular outcomes, AHA publications should be referenced.

The most recent AHA has been referenced and included in the PM2.5 section.

2. On page I-36, the sentence about blood pressure in the middle of metabolic effects section is out of place.

High blood pressure is tied to obesity and thus one of the factors.

3. For PM2.5, short-term cardiovascular effects did not include subclinical effects. Studies on adverse birth outcomes were not included in the short-term health effect section, but mixed with long-term health effects. Usually, trimester and full pregnancy exposures would be considered long-term exposures, while exposures within a few day(s) or one week prior to delivery would be considered short-term exposures.

We have added in subclinical effects and for the birth outcomes we have made a note in the short-term section to reference the long-term section.

4. For the sensitive population sections under ozone and PM, I suggest adding the population size and percentage of the SCAQMD territory in the table or text, if available (unless that will be covered in the economic report?). The younger and higher percentage of non-White populations in this region may exacerbate health risks from ambient air pollution.

This comment is addressed in the socioeconomic analysis for the 2022 AQMP. The detailed report can be found here: [Socioeconomic Analysis](#).³

³ <http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/socioeconomic-analysis>

5. For the health burden analysis of ozone and PM in the South Coast Air Basin, more explanation is needed about the analysis in the 2016 AQMP. Were the 1,400 and 2,700 premature deaths for 2023 and 2031, respectively, reported annually? How was “an average of about 1,500 avoided premature deaths per year” calculated? Was it based on the projected air concentrations without control?

Table I-8, why wasn’t short-term PM2.5 exposure included in the mortality-related benefits?

There are new resources/tools available to estimate the health burden associated with air pollution exposure, e.g., CalEnviroScreen, California Healthy Places Index, ATSDR/CDC Social Vulnerability Index, etc. SCAQMD should consider redoing the risk estimate using newer data.

This section has been removed from Appendix 1 and is more appropriately discussed in the socioeconomic analysis for the 2022 AQMP. The detailed report can be found here: [Socioeconomic Analysis](#).⁴

6. For NO₂, subtitles by short/long-term outcomes would be appreciated, at least for the major categories: respiratory, cardiovascular, other outcomes, etc.

This section has been reorganized and labelled.

7. The “Toxic Air Contaminants” section does not include any health effects associated with TACs.

TACs is a large category for which individual contaminants can be researched. We have included only a discussion on diesel and VOCs.

Comment Letter #85

From: Osterman, Gregory B (US 3291) <gregory.b.osterman@jpl.nasa.gov>

Sent: Saturday, August 13, 2022 2:44 PM

To: Sang-Mi Lee <slee@aqmd.gov>

Subject: Air Quality and Health Appendix - Comments

Hi Sang-Mi,

I apologize for this being late. I did go through the Air Quality and Health appendix, though I focused mostly on the ozone sections. The document looks to be very thorough, with an impressive amount of referenced support for the need to help alleviate the effects of air quality on human health.

I did not ask any questions during the meeting, I felt my questions were asked by other members of the committee and answered during the meeting. My questions had to do with the ISA, which I was not too familiar with. The relationships in table I-2 seem to be very conservative when describing the risks to health from ozone exposure, but now I understand that they are defined by the EPA. The case for the effects of ozone on health is still overwhelmingly made in the document.

⁴ <http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/socioeconomic-analysis>

Also I know that the team that wrote the appendix had to stop at some point and could not consider the most recent papers. I did a quick search and found the attached paper that started with the same premise as table I-2, that the relationship between long-term ozone exposure and cardiovascular mortality has not been established as causal. The findings of the paper seem to support the relationship and add to the evidence that there might be a causal relationship. Maybe the team already saw this paper, I just found it and thought I would pass it along.

Lastly, and this is closer to the subject area I am more familiar with, I did not see any papers from the NASA Health and Air Quality Applied Science Team about air quality and health effects that utilize satellite data. These are more recent papers (publication list [here](#)), so maybe they came out after the appendix draft was completed. But there seem to be some papers that might help illustrate the relationships between PM2.5, NO2 or ozone and health. As you know the satellite data has limitations, but is good at looking at larger areas or away from places with surface instrumentation. In particular, Susan Anenberg's group has published some interesting papers ([link](#)). The appendix is very thorough, it might not need the satellite papers, but I thought I would point them out.

Again, great job by the SCAQMD team working on the draft AQMP and the health effects appendix in particular.

Best regards,

Greg

We appreciate your comments and suggestions. We have included the paper that you have cited on ozone exposure and cardiovascular mortality (See page 44). In the Recent Research and Upcoming Topics Section, we have included a subsection on satellite data citing some of the papers you have mentioned.

Comment Letter #86

From: Holmes-Gen, Bonnie@ARB <bonnie.holmes-gen@arb.ca.gov>

Sent: Monday, August 15, 2022 5:54 PM

To: Sang-Mi Lee <slee@aqmd.gov>

Cc: Scheehle, Elizabeth@ARB <Elizabeth.Scheehle@arb.ca.gov>

Subject: Input for SCAQMD Advisory Council

Thank you Sang-Mi for the opportunity to participate in the SCAQMD Advisory Council. Per our discussion on Thursday, I am attaching CARB/OEHHA and CARB/OEHHA/CalEPA comments that were submitted in response to the EPA ISA and policy documents for PM 2.5 and Ozone. These comments include references to epidemiological research demonstrating strong evidence of effects below the current federal standards as well as gaps in information that should be addressed in updating federal ozone and PM 2.5 standards to ensure that vulnerable populations including low-income communities and communities of color, are protected. Please let me know how I can provide further assistance. Thank you and we look forward to hearing from you on next steps.

Bonnie Holmes-Gen

Bonnie Holmes-Gen

Branch Chief
Health and Exposure Assessment Branch
California Air Resources Board
bonnie.holmes-gen@arb.ca.gov
Pronouns: she/her



Thank you for providing us these supporting documents. We have reviewed the different attachments and included the references cited.

Summary of Comments from the Advisory Council Meeting on August 10, 2022 w/Response

There were several comments that expressed broad interest to review the socioeconomic analysis and health benefits associated with the 2022 AQMP. A few council members wanted to see how air quality and health impacts differentiated by race, ethnicity, and geographic location. There was also a request to assess the dual impacts of heat waves on air pollution and health effects. Further, there was a comment to discuss the limitations of the studies cited to address the health impacts of Covid-19. Finally, there was a comment to evaluate the health effects of cumulative exposure to multiple health effects.

To address the comments pertaining to the socioeconomic analysis staff held an additional Advisory Council meeting to discuss the results of the socioeconomic analysis. The detailed report can be found here: [Socioeconomic Analysis](#).⁵

The topics of health impacts from heat waves and COVID-19 were expanded on in the Recent Research and Upcoming Topics section and the limitations were discussed there as well.

Regarding cumulative exposure of multiple air pollutants, staff agrees that cumulative exposures are an important consideration. However, the regulatory framework and the control measures developed in the 2022 AQMP are pollutant-specific for six major outdoor pollutants covered under section 108 and 109 of the Clean Air Act. This is appropriate, in that different pollutants can differ in their sources, their times and places of occurrence, the kinds of health effects they may cause, and their overall levels of health risk. Different pollutants, from the same or other sources, often occur together. Evidence from recent studies is consistent in supporting an association between a single pollutant concentrations and respiratory health effects independent of coexposures to correlated pollutants. For example, across pollutants, single-pollutant associations reported between ozone and a range of respiratory-related

⁵ <http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/socioeconomic-analysis>

hospital admissions and emergency department (ED) visits were persistent, although sometimes lessened, in copollutant models (U.S. EPA, 2020). While the combined effects of multiple air pollutants that occur simultaneously is important, single-pollutant associations still hold true. Furthermore, the air quality standards address each criteria pollutant separately. Therefore, this Appendix is divided into sections by pollutant.

Summary of Comments Related to Health Effects from the Joint Meeting of the Advisory Council and the STMPR Advisory Group on October 5th, 2022 w/Response

There was only one comment directly related to the health effects analysis of Appendix 1 from this meeting. This comment was from Dr. James Enstrom that referenced his written comments he submitted for review of Appendix 1. He requested that we review the state of the science around personal exposure to ozone and PM2.5, wherein he challenges that actual personal exposure is below the NAAQS, as well as the reported human health effects.

Staff have included a response to Dr. James Enstrom's written comment. We have also included this opinion in the introduction of Appendix 1, where we have provided a link to the additional research that Dr. Enstrom has cited.