Addendum I – Proposed Research Projects for Fiscal Year 2022-2023

Introduction

On March 25, 2021, the Board approved the Fiscal Years 2021-2024 Triennial Strategic Research Plan (Plan). The Plan provides details on past and current research activities, as well as remaining research needs that serve as a guide for the development of future research projects that will support of the Board's mission.

For Fiscal Year 2022-2023, CARB is proposing seven research projects that each address multiple research initiatives identified in the Triennial Strategic Research Plan. By implementing these projects, CARB can address long-term goals and challenges holistically. CARB is also proposing two white papers that will analyze the state of the science and identify research gaps for emerging priority areas to shape future research projects.

The research program continues to focus on issues that are unique to California and its priority populations and communities, and to leverage and complement research supported by other funding organizations. The projects proposed for Fiscal Year 2022-2023 will inform the state's efforts to maximize health, environmental, and economic co-benefits, create additional health endpoints to assess our programs, leverage new tools and methods to identify and refine mitigation strategies to support air quality goals, and support the equitable development of sustainable communities.

The proposed research projects will support the Board's decision-making and effective program implementation. A research budget of approximately $3.8 million is anticipated to fund seven new projects and two white papers in fiscal year 2022-2023.

Board approval of the Proposed 2022-2023 Research Projects will authorize staff to proceed with developing these research projects.

Additional funds for research to support sustainable community and transportation programs may become available late in fiscal year 2022-2023. A list of additional projects is provided after the proposed projects that may be funded if these topic-specific funds become available.

TABLE 1: SUMMARY TABLE OF PROPOSED PROJECTS FOR FY22-23

Project Titles	Cost
Expanded health analysis of metabolic and neurodevelopmental health outcomes (including learning disabilities and diabetes)	$975k
Studying intergenerational impacts in different racial/ethnic contexts	$500k
Development of a Research Roadmap through Community Engagement – Focus on Toxics	$100k

Characterization of possible air pollutants emissions and health effects associated with air cleaning devices with electronic technologies (white paper)	$25k
Characterization of tire-wear and brake-wear PM emissions under on-road driving conditions	$650k
Understanding the link between volatile chemical products (VCP), secondary organic aerosol (SOA), and California's current atmospheric chemical regime(s)	$200k
Determine emission factors and chemical speciation from burning structures due to wildfires in California for use in air quality and health impact assessments	$650k
Estimating costs, benefits and strategies for equitable electrification of high priority commercial buildings	$450k
Wildfire Messaging: Improving Health, Increasing Resource Efficiency, and Policy Applications for CARB Programs (white paper)	$250k
TOTAL	$3.8M

Project Descriptions

Expanded Health Analysis of Metabolic and Neurodevelopmental Health Outcomes (Including Learning Disabilities and Diabetes)

CARB has, in response to Board resolution 20-13, launched an expanded health analysis project to evaluate a broader range of health benefits from air pollution control efforts than those routinely analyzed and monetized in the regulatory review process. Currently, CARB analyzes three specific health endpoints for PM2.5. However, emerging research findings provide evidence for additional air pollution-related health outcomes beyond what CARB currently quantifies. The goal of this project is to provide a broader scientific basis for the evaluation and quantification of California-relevant associations between air pollutants. (e.g., criteria pollutants, air toxics,) and additional health outcomes. Thus, CARB is seeking proposals for two priority areas of current research interest. CARB will be funding each priority area separately, as two different projects.

1. Adverse metabolic outcomes, such as type 2 diabetes, stroke, or liver disease associated with air pollutant exposure, OR

2. Children's neurodevelopmental effects, such as learning disabilities and developmental delays, EXCLUSIVE of autism, associated with air pollutant exposure.

A California-based study is preferred, but data from other areas in the U.S. or Canada could be included. The objective for each project will be to use an air pollution exposure modeling approach to identify concentration-response functions between air pollutants and a variety of health endpoints within those two priority areas, monetized

values (actual financial costs and/or valuations, such as willingness to pay) for those health impacts, and associated uncertainties. Evaluating data for racial and ethnic subgroups and providing concentration-response functions for subgroups as data allows will be required for both projects in addition to average population health data and concentration-response functions. The results of this project will allow for expanded evaluation and quantification of public health benefits from CARB actions and their associated economic values, as well as identification of potential qualitative outcomes. We encourage multidisciplinary teams and multi-university teams to apply.

Cost estimate: 1. Adverse metabolic outcomes: $475,000

2. Children's neurodevelopmental effects: $500,000

Studying Intergenerational Impacts in Different Racial/Ethnic Contexts

A history of redlining and environmental injustice has resulted in some communities in areas with a higher burden of pollution exposure due to the many sources of air pollution located in and near these communities. Examining how pollution exposures differ across generations within a family, and how these intergenerational exposures and health effects differ by race can give insight into the magnitude and persistence of these pollution burdens and inform air pollution control efforts. This study is intended to investigate the persistence of existing racial inequities in exposure to criteria and toxic air pollutants among families and try to determine whether these inequities are increasing or decreasing in the next generation. The exposure patterns will be investigated to also examine the potential health impacts across generations, including asthma, and compare health impacts in families that continued to live in elevated exposure areas vs. those who moved to lower pollution areas. The latest available air quality exposure data should be combined with residential and demographic data to understand intergenerational exposures for families in California, and data should be disaggregated by race, income and location. Health impacts will be investigated through analysis of exposure data and health data utilizing databases or cohorts to compare health concerns in parents and children. There will be a significant public outreach component to this project and study methods and results will be shared using clear and direct communication materials. This project will shed light on mechanisms driving changes in exposure in disadvantaged communities including tribal communities and help to identify appropriate policy responses and support CARB's work to better protect vulnerable communities.

Cost estimate: $500,000.

Development of a Research Roadmap through Community Engagement – Focus on Toxics

Despite achieving large reductions in air pollutant concentrations state-wide, various communities throughout the state experience larger than average exposures to

pollutants. Toxic emissions from industrial point sources are a concern that continue to be highlighted by community advocates. In an effort to leverage community expertise and center community voices, this project aims to co-create a research roadmap centered on toxic pollutant emissions from industrial sources. The objective of this research is to fund a community engagement project for communities interested in setting research priorities related to identifying sources, understanding health impacts, and developing exposure mitigation strategies. The project lead will gather all available information and data on toxic emission sources, exposure, and mitigation from the academic literature, government documents, and information already gathered from communities in past public meetings and engagement processes. The project lead will also partner with community representatives and relevant community organizations to identify community priorities and design a future research framework. The results of this study will provide a comprehensive evaluation of known emissions sources, processes, and air quality related health issues, as well as a research plan co-created with the community. This engagement will help CARB develop better projects around sources of concern. The engagement may focus on specific communities, but the research roadmap will be applicable to a wide range of communities affected by similar point sources.

Cost estimate: $100,000

Characterization of Air Pollutant Emissions and Possible Health Effects Associated with Air Cleaning Devices Using Electronic Air Cleaning Technologies (White Paper)

Air cleaning devices can greatly improve indoor air quality by removing particulate matter from the air. However, some of these devices include electronic air cleaning technologies, such as ionizers, UV lamps, or photocatalytic oxidation, to increase the efficiency of particulate removal. The use of electronic air cleaning technologies may result in the production of additional air pollutants or pose an exposure risk, including to UV radiation, which may have potential health impacts. Therefore, the goal of this white paper is to document available research on the formation of non-ozone air pollutants and potential health effects from the use of air cleaners with electronic air cleaning components. The paper will also summarize the current knowledge on the potential hazards associated with electronic air cleaning technologies, outline types of studies that may be needed to address knowledge gaps and provide recommendations about additional assessment needed, or opportunities to reduce hazards from devices. This project will assist CARB in its efforts to protect public health by considering additional possible air quality hazards associated with the use of air cleaning devices.

Cost estimate: $25,000

Characterization of Tire-Wear And Brake-Wear PM Emissions Under On-Road Driving Conditions

Non-exhaust PM emission from on-road vehicles, including airborne dust from brake and tire-wear, has raised concerns due to its potential regional PM contribution and impact on nearby communities. However, there are currently no commonly accepted brake and tire-wear real-world emission test methods that have been established and adopted worldwide. Therefore, the objective of this research is to characterize real-world tire and brake-wear PM emissions for California representative light-duty and heavy-duty vehicles powered by gasoline, diesel, and electricity. Two previous brake-wear studies have measured brake-wear PM emission factors based on dynamometer laboratory testing. In this research, real-world brake and tire-wear PM emission measurements will be conducted to characterize California-specific vehicle brake-wear, tire-wear, and road dust PM emissions separately, as well as to be compared to previous laboratory-based study results. In the development of the test matrix, likelihood factors affecting tire-wear PM will be considered, such as California relevant tire products and their market share, road pavement materials, road types (highway, arterials, and local roads), roadway geometry, etc. The results from this research will be used to update the EMFAC emission inventory, understand the impact of moving to electric vehicles on the brake and tire-wear emissions, inform health impact analysis, and inform the low carbon transportation (LCT) incentive program and California Energy Commission's (CEC) tire efficiency standard development.

Cost estimate: $650,000

Analysis of Particulate Matter Composition Measured in Los Angeles, CA During RECAP-LA

Although air quality in the South Coast Air Basin (SoCAB) has greatly improved over the last several decades as a result of California's regulatory policies, the particulate matter (PM) concentration in the SoCAB has not decreased substantially in recent years, and the underlying reasons for this lack of improvement are poorly understood. The objective of this research is to analyze recently collected air quality data from an intensive field campaign in the SoCAB to improve understanding of the sources and processing of local organic and inorganic PM. This work will leverage state-of-the-science aerosol- and gas-phase composition data that was collected during the 2021 ReEvaluation of California Air Pollution (RECAP-LA) atmospheric field campaign in Pasadena, CA. This project will also compare current with previous ambient measurement campaigns in Los Angeles (e.g., the California Nexus 2010 or CalNex-2010 atmospheric field campaign) and assess the relative role of changing emissions, atmospheric chemistries, and oxidant concentrations on past and future trends in organic PM concentrations. These analyses will assist in the development of regulatory

policies critical to improving air quality in the SoCAB and attaining compliance with the federal annual PM2.5 standard.

Cost estimate: $200,000

Determine Emission Factors and Chemical Speciation from Burning Structures Due to Wildfires in California for Use in Air Quality and Health Impact Assessments

Extreme wildfire events, both in terms of acres burned and associated infrastructure losses, have been increasing in recent years with the seven largest wildfires in recorded California history occurring since 2015. Many of these large wildfires happened at the wildland-urban interface (WUI), where human made structures became engulfed in these wildfires. The recent increase in destructive capacity of wildfires throughout the western United States has led to an increase in the frequency and scale of structural fires. It is now becoming common that entire communities are being impacted by wildfire and structures are being incinerated. There is limited information on emissions from the structural components of wildfires and more information will allow CARB to better estimate emissions, air quality, and health impacts.

This project will determine emission factors (EFs) and chemical speciation from burning structures typical of those located in California due to wildfires. The EFs will be compared to prior research and the researchers will participate in a broader effort being funded at the National Institute of Standards and Technology (NIST), funded by CalFire. NIST plans to burn a series of full-scale structures built to California building code standards, including both real building materials and building contents. Planned burns include full-scale accessory dwelling units (ADUs) and single-family homes.

Investigators will measure emissions using a drone-based collection and sampling system and measure particles, carbon dioxide, carbon monoxide, Volatile Organic Compounds (VOCs), and Intermediate-Volatility Organic Compounds (IVOCs) and Semi-Volatile Organic Compounds (SVOCs), PM2.5, metals, and organic and elemental carbon.

The results of this study will enable more accurate estimates of the structural emissions from wildfire to then estimate air quality impacts associated with structures within wildfires. This work will provide CARB the ability to estimate the potential benefit of decreased destructive capacity of wildfires through increases in future forest management and increased defensible space.

Cost estimate: $650,000

Estimating Costs, Benefits and Strategies for Equitable Electrification of High Priority Commercial Buildings

Building decarbonization is a critical measure to achieve California's climate and air quality goals and protect public health; in particular, building electrification is one building decarbonization strategy that can eliminate direct emissions from stationary combustion. However, commercial building electrification remains a challenge due to the complexity of building functions, types of natural gas equipment used for space heating, water heating, cooking, and clothes drying in commercial buildings, and other challenges inherent to retrofitting existing buildings and constructing new buildings. The objectives of this research are:

1) Identify high priority subsectors for commercial building electrification, and analyze the costs, benefits, and strategies to decarbonize commercial buildings in a way that equitably benefits communities. High priority subsectors are those with disproportionate emissions and exposure impacts to frontline communities and priority populations. This work will leverage existing programs and customer data to characterize the natural gas equipment used in CA commercial buildings and available emissions data to characterize air quality impacts.

2) For high priority commercial building subsectors identified pursuant to objective 1, the project will estimate the impacts of their natural gas equipment use, including space heating, water heating, cooking and clothes drying equipment, on local, regional and overall statewide energy consumption, indoor and outdoor air quality, health risks (based on outdoor pollution emissions), environmental equity and climate change.

3) Analyze the electrification costs, benefits, and enabling and limiting factors in converting high priority commercial building sectors from natural gas to electricity. In addition, the project will analyze what is needed to close the gaps between existing efforts in these subsectors and the state's long-term goals.

The results of this study will be air quality, climate, and health impact data for priority commercial building subsectors as well as recommendations and strategies useful in the development of complementary regulatory actions to enhance equitable electrification for CA commercial buildings.

Cost estimate: $450,000

Wildfire Smoke Messaging: Improving Health, Increasing Resource Efficiency, and Policy Applications for CARB Programs (White Paper)

The wildfire season in California is becoming longer and more destructive, exposing more Californians to wildfire smoke. The state has worked hard to provide Californians with information on how to mitigate exposure to smoke in indoor and outdoor environments, however, the efficacy of the methods used to disseminate this information has not been tested, nor have the methods and messages been optimized for vulnerable Californians that may not have access to safe indoor environments. This

project integrates research into a messaging campaign to protect people's health during wildfires by measuring website visits and clean air center attendance connected to specific messaging strategies. CARB will lead the research project using in-house expertise and will coordinate with Air Districts and local partners. The project stages are: 1) interviews and surveys of practitioners, stakeholders, and experts to identify potential messaging strategies, 2) implementation of a messaging strategy with a statistically powerful design that estimates the causal effect of messaging, and 3) measurement of actual attendance at clean air centers and website visits to assess the relative efficacy of each message. Results from this work will provide practical guidance to improve public messaging strategies to mitigate wildfire smoke exposure. The project will provide these insights by testing different messaging strategies that could include message frames (personal health vs ease of use), message media (physical mail vs text messages), and targeting specific groups (messages specific to priority communities). This project integrates practice and research to address CARB's goals to protect the health of Californians from harmful air quality. In addition, guidance from this work will be transferable to other CARB programs to improve outreach. Staff will consider the feasibility of evaluating other wildfire exposure mitigation messaging.

Cost estimate: $250,000

Additional Project Priorities

Additional funds for research to support sustainable community and transportation programs may become available late in fiscal year 2022-2023. Below is a list of project topics related to sustainable transportation and communities that have a high potential of getting funded and being developed into full project concepts if additional funding is secured.

- Vehicle miles traveled (VMT) - Strategies to reduce VMT and assessment of impacts from emerging technologies like connected and shared autonomous vehicles as well as impacts from telework
- Buildings - Assessment of strategies to advance equitable building decarbonization
- Light duty zero emission vehicles in the secondary market: Policies and equity
- California Climate Investments – Greenhouse gas quantification and co-benefit assessment methods
- Housing - Assessment of combined housing and transportation costs and strategies to advance equity
- Local government climate action – Assessment of barriers and opportunities