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Methods to Assess Co-Benefits of California Climate Investments

Air Pollutant Emissions

Sustainable Communities and Clean Transportation Sector and Energy Efficiency and Clean Energy Sector

California Air Resources Board

I. Background

Under California's Cap-and-Trade Program, the State's portion of the proceeds from Cap-and-Trade auctions is deposited in the Greenhouse Gas Reduction Fund (GGRF). The Legislature and Governor enact budget appropriations from the GGRF for State agencies to invest in projects that help achieve the State's climate goals. These investments are collectively called California Climate Investments (CCI).

Senate Bill 862[1] requires the California Air Resources Board (CARB) to develop guidance on reporting and quantification methods for all State agencies that receive appropriations from the GGRF. Guidance includes developing quantification methodologies for greenhouse gas (GHG) emission reductions and other social, economic, and environmental benefits of projects, referred to as "co-benefits."

This document is one of a series that reviews the available methodologies for assessing selected co-benefits for CCI projects at two phases: estimating potential project-level co-benefits prior to project implementation (i.e., forecasting of co-benefits) and estimating actual co-benefits after projects have been implemented (i.e., tracking of co-benefits). The assessment method at each of these phases may be either quantitative or qualitative. As with CARB's existing GHG emission reduction methodologies, these co-benefit assessment methods will be developed to meet the following standards:

- Apply at the project level,
- Align with the project types proposed for funding for each program,
- Provide uniform methods to be applied statewide, and be accessible by all applicants,
- Use existing and proven tools or methods where available,
- Use project level data, where available and appropriate, and
- Reflect empirical literature.

[1] SB 862, Chapter 36, Statutes of 2014, Health and Safety Code Section 39715.

CARB, in consultation with administering agencies, has selected ten co-benefits to undergo methodology assessment and development under a contract with University of California, Berkeley. CARB is also evaluating two additional co-benefits, air pollutant emissions and vehicle miles traveled (VMT). This document reviews available data and methods to assess the ***air pollutant emissions*** co-benefit for both the Sustainable Communities sector and the Clean Transportation sector and the Energy Efficiency and Clean Energy sector. It identifies:

- the direction and magnitude of the co-benefit,
- the limitations of existing empirical literature and data,
- the existing assessment methods and tools,
- other issues to consider in developing co-benefit assessment methods, and
- a proposed assessment method for further development.

This assessment is specific to CCI programs in the Sustainable Communities and Clean Transportation sector and the Energy Efficiency and Clean Energy sector. Further research is required to assess the air pollutant emission co-benefits of CCI projects in the Natural Resources and Waste Diversion sectors. CARB will continue to research the air pollutant emission co-benefits of CCI projects in the Natural Resources and Waste Diversion sectors and will release a separate assessment of methods to assess the air pollutant emission co-benefits for these projects at a later date. CARB prioritized transportation and energy related projects, consistent with the quantification needs of programs with continuous appropriations established by SB 862. CARB has the goal of integrating air pollutant emission co-benefits into FY 2017-18 quantification methodologies, to the extent feasible.

II. Co-Benefit Description

Air pollution is a general term used to describe undesirable amounts of particulate or gaseous matter in the atmosphere. Some air pollutants are visible such as the reddish-brown haze in smog; however, other air pollutants, including some of the most dangerous, are invisible. Very small amounts of these pollutants can cause serious health and environmental problems. Very fine particulate pollution is particularly dangerous since it burrows deep into the lungs where it can enter the bloodstream and harm the heart and other organs. Fine particulate pollution poses an especially critical health danger for children, the elderly, and people with existing health problems. Air pollution is also harmful to crops and property values. In California, our cities are among the smoggiest urban areas in the country (CARB, 2010). Smog, or ground-level ozone, result from emissions of reactive organic gases (ROG) and nitrogen oxides (NOx). Other air pollutants, such as toxic air contaminants (toxics), may cause serious adverse health effects with short- or long-term exposure. Despite significant success in reducing overall pollution levels, air pollution continues to be an important public health problem (CARB, 2015a). Criteria and toxic air pollutants are of particular concern to

public health. Recent legislation, Assembly Bill (AB) 617[2] and AB 398[3], underscore the importance of reducing air pollution and prioritize GGRF funding for investments that reduce criteria and toxic air pollutant emissions from stationary and mobile sources.

While there are many air pollutants that may be relevant to CCI projects, CARB staff recommends evaluating the following criteria and toxic air pollutants in the initial co-benefit assessment method:

- Criteria Pollutants
  - Particulate Matter ($PM_{2.5}$)
  - Nitrogen Oxides (NO_X)
  - Reactive Organic Gases (ROG)
- Toxic Air Pollutants
  - Diesel Particulate Matter (diesel PM)

These air pollutants are prioritized for assessment based on their prominence in State Implementation Plans (SIPs), which describe how an area will attain national ambient air quality standards established by federal clean air laws (CARB, 2017d). They were also selected due to their high concentration levels and the associated health risks. Concentrations of $PM_{2.5}$, NO_X, and ROG are high relative to the other criteria pollutants displayed in EMFAC 2014 (short for EMission FACtor) (CARB, 2014). Diesel PM is the most common airborne toxic that Californians breathe and it is estimated that about 70 percent of the total known cancer risk related to air toxics in California is attributable to diesel PM (CARB 2017d). CCI projects that reduce emissions of the selected criteria and toxic air pollutant emissions can improve both air quality and related public health outcomes. Additional air pollutants may be added for future iterations of the assessment method.

III. Directionality of the Co-Benefit

CCI projects in the Sustainable Communities and Clean Transportation sector and Energy Efficiency and Clean Energy sector can help support reductions in air pollutant emissions through measures including reducing VMT, switching to cleaner fuels, incentivizing or zero emission vehicles, reducing energy consumption, or displacing fossil fuel based energy. Table 1 illustrates the CCI programs for which air pollutant emission benefits (or dis-benefits) are most likely to accrue once a project is operational.

[2] AB 617, C. Garcia, Chapter 136, Statutes of 2017.
[3] AB 398, E. Garcia, Chapter 135, Statutes of 2017.

Table 1: CCI Programs Affected by Co-Benefit

Administering Agency	Program	Likely direction of co-benefit (+ = beneficial change)
Sustainable Communities and Clean Transportation		
CARB	*Low Carbon Transportation*	+
Caltrans	*Active Transportation Program*	+
	Low Carbon Transit Operations Program	+
HSRA	*High Speed Rail*	+
CalSTA	*Transit and Intercity Rail Capital Program*	+
SGC	*Affordable Housing and Sustainable Communities Program*	+
	Transformative Climate Communities	+
Energy Efficiency and Clean Energy		
CARB	*Woodsmoke Reduction Program*	+
CSD	*Low Income Weatherization Program*	+
	Community Solar	+
CDFA	*State Water Efficiency and Enhancement Program*	+
DWR	*Water-Energy Grant Program*	+

IV. Magnitude of the Co-Benefit

All CCI projects in the Sustainable Communities and Clean Transportation sector and Energy Efficiency and Clean Energy sector are expected to result in air pollutant emission reductions. At the project level, the magnitude of the co-benefit will depend on individual project characteristics. Overall, air pollutant emission co-benefits are likely to be significant when considered across the entire CCI portfolio. Further research is required to assess the air pollutant emission co-benefits of projects in the Natural Resources and Waste Diversion sectors.

V. Limitations of Current Studies

Criteria and toxic air pollutant emissions associated with the Sustainable Communities and Clean Transportation sector and Energy Efficiency and Clean Energy sector are well documented. CARB will move forward at this time with quantifying air pollutant emission co-benefits for CCI projects in these sectors. CARB will continue to research the air pollutant emission co-benefits of CCI projects in the Natural Resources and Waste Diversion sectors with the goal of having methods ready for use upon the

Legislature appropriating additional funding and CARB posting new FY 2017-18 quantification methodologies.

VI. Existing Quantification Methods and Tools

CARB staff evaluated existing quantification methodologies and data sources to estimate criteria and toxic air pollutant emissions from CCI projects. The sections below discuss the materials reviewed and their applicability.

Sustainable Communities and Clean Transportation Sector
Existing quantification methodologies and data sources reviewed for CCI projects within the Sustainable Communities and Clean Transportation sector are summarized in Table 2.

Table 2: Applicability of Evaluated Criteria and Toxic Air Pollutant Emission Quantification Methods and Data Sources

Data Source	Applicability
CARB EMFAC 2014	• Criteria and toxic pollutant emissions for on-road vehicles • Tailpipe exhaust criteria and toxic air pollutant emissions
CARB Low Carbon Transportation (LCT) Quantification Methodologies	• Methods to assess criteria and toxic air pollutant emissions from diesel engines
CARB Emissions inventory for off-road equipment	• Criteria and toxic pollutant emissions for off-road equipment
CARB LCFS Pathways	• Well-to-wheel GHG emissions • Carbon intensities of fuel
CARB California toxics inventory	• Toxic air pollutant emissions when additional project-specific information such as engine type and operating hours is available
CARB Goods Movement Emissions Reduction Program	• Criteria and toxic air pollutant emissions when additional project-specific information such as engine type and operating hours is available
CARB Carl Moyer Program Guidelines	• Criteria and toxic air pollutant emissions when additional project-specific information such as engine type and operating hours is available
CARB emission methodology for Commercial Harbor Craft	• Criteria and toxic pollutant emissions for commercial harbor craft
United States Environmental Protection Agency (U.S. EPA) emission factors for locomotives	• Criteria and toxic pollutant emissions for locomotives

Energy Efficiency and Clean Energy Sector
Existing quantification methodologies and data sources reviewed for CCI projects within the Energy Efficiency and Clean Energy sector are summarized in Table 3.

Table 3: Applicability of Evaluated Criteria and Toxic Air Pollutant Emission Quantification Methods and Data Sources

Tool	Applicability
CARB GHG emissions inventory	• Criteria and toxic air pollutant emissions for electricity grid average emission factor
U.S. EPA emission factors for GHG inventories	Criteria and toxic air pollutant emissions • Natural Gas • Propane • Kerosene • Fuel Oil
CARB LCFS pathways for electricity and natural gas	• Well-to-wheel GHG emissions (criteria and toxic air pollutant emissions not documented) • Carbon intensities and energy densities of fuels
CARB California criteria air pollutant emissions inventory for stationary sources	• Criteria and toxic air pollutant emissions for in-state generation only (does not include imports)
CEC Energy Almanac	• Criteria and toxic air pollutant emissions for California in-state generation and imported electricity
U.S. EPA Compilation of Air Pollutant Emission Factors (AP-42)	• Criteria and toxic air pollutant emissions for residential fireplaces and woodstoves
U.S. EPA Regulatory Impact Analysis for Residential Wood Heaters	• $PM_{2.5}$ emissions for residential woodstoves
CARB Methodology for Residential Wood Combustion	• Criteria and toxic air pollutant emissions for residential fireplaces and woodstoves • Equations for air pollutant quantification

VII. Other Issues to Consider in Developing Co-Benefit Quantification Methods for Air Pollutant Emissions

Sustainable Communities and Clean Transportation CCI programs estimate GHG emissions using a life-cycle or "Well-to-Wheels" approach, which consists of GHG emissions resulting from the production and distribution of different fuel types, including hydrogen and electricity, and any associated tailpipe exhaust emissions. In contrast to GHG emissions, however, it is more appropriate to estimate criteria and toxic air pollutant emissions using a "Tank-to-Wheels" approach, which is an estimate of emissions associated with tailpipe exhaust. This approach is most appropriate for use in estimating criteria and toxic air pollutant emissions for two primary reasons.

1) Unlike GHG emissions, the impacts of criteria and toxic air pollutant emissions are local in nature and the production and distribution of fuels often take place in locations other than where the fuels are combusted. The Tank-to-Wheels

approach therefore avoids overestimating the CCI project air pollutant emission co-benefits for local areas and populations.

2) Criteria and toxic air pollutant emissions are not solely determined by the type of fuel being combusted, rather they also depend on the type of engine in which they are combusted as well as any control technologies that may be employed.

VIII. Proposed Method/Tool for Use in Further Development

CARB staff recommends developing emission factors for criteria and toxic air pollutant emissions appropriate for CCI projects. For the Sustainable Communities and Clean Transportation sector and Energy Efficiency and Clean Energy sector, this would involve using the most appropriate data sources to develop emission factors that apply to reductions in VMT, switching to cleaner fuels, incentivizing zero emission vehicles, reductions in energy consumption, or displacing fossil fuel based energy.

Sustainable Communities and Clean Transportation
Of the available resources evaluated, CARB staff recommends the data sources listed in Table 4 be used to develop criteria and toxic air pollutant emission factors, by equipment type.

Table 4: Recommended Data Sources for the Sustainable Communities and Clean Transportation Sector

Equipment Type	Data Source
On-road vehicles	• EMFAC
Ferries	• CARB's emission methodology for Commercial Harbor Craft
Locomotives	• EPA emission factors for locomotives

Energy Efficiency and Clean Energy
Of the available resources evaluated, CARB staff recommends the data sources listed in Table 5 be used to develop criteria and toxic air pollutant emission factors, by fuel or energy type.

Table 5: Recommended Data Sources for the Energy Efficiency and Clean Energy Sector

Fuel or Energy Type	Data Source
Heating Fuels	• U.S. EPA emission factors for GHG inventories
Grid Electricity	• CARB GHG Inventory • CEC Energy Almanac
Fuel Specific	• LCFS Pathways
Residential Heating Devices	• U.S. EPA Compilation of Air Pollutant Emission Factors (AP-42), • U.S. EPA Regulatory Impact Analysis for Residential Wood Heaters • CARB Methodology for Residential Wood Combustion

Air pollutant emission factors for the Sustainable Communities and Clean Transportation sector and Energy Efficiency and Clean Energy sector have the added benefit of being integrated into CARB's existing quantification methodologies for CCI projects and utilizing the same methods already used to estimate GHG emission reductions. The same emission factors could be used to estimate air pollutant emission co-benefits prior to and after CCI funds are awarded. As criteria and toxic air pollutant emission factors are developed, CARB staff recommends:

- Including draft criteria and toxic air pollutant emission factors in the CCI Quantification Methodology Emission Factor Database;
- Documenting how the criteria and toxic air pollutant emission factors were developed in the CCI Quantification Methodology Emission Factor Database Documentation; and
- Adding air pollutant emission calculations and a new output tab to existing CARB calculator tools for FY 2017-18 quantification methodologies to estimate a project's air pollutant emission co-benefits in addition to GHG emission reductions.

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