APPENDIX T

PROPOSED

LEV III MOBILE SOURCE EMISSIONS INVENTORY

TECHNICAL SUPPORT DOCUMENT

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1 Introduction

There are about 25 million cars that currently operate in California; that number is expected to grow to more than 30 million by 2035. Despite stringent regulations that have been very successful in reducing emissions, passenger vehicles are currently responsible for roughly 20 percent of all smog-forming emissions in California. Passenger vehicles are also responsible for about 25 percent of all greenhouse gas emissions in California, which makes them an important source to control to meet greenhouse gas emissions reductions targets. The proposed Advanced Clean Cars (ACC) regulation aims to reduce future criteria and greenhouse gas emissions by requiring new vehicles sold into the market to meet newer more stringent emissions standards. This chapter describes the methods used to assess the emissions inventory from passenger cars, and the benefits of the proposed regulation on criteria pollutant and greenhouse gas emissions.

2 Emissions Inventory Methods

This section provides a detailed discussion of how emissions inventories, both criteria pollutant and greenhouse gas were assessed to develop baseline emissions estimates and emissions under various proposed and alternative regulatory scenarios.

2.1 Overview

In California, the EMFAC model is used to assess emissions from on-road passenger vehicles. The latest version of the model, EMFAC2011, was released in September 2011. EMFAC2011 is comprised of three modules; EMFAC2011-LDV is the module used to calculate emissions from gasoline vehicles, diesel vehicles <14,000 pounds gross vehicle rated weight, urban transit buses, and motorhomes. EMFAC2011-LDV is informed by the latest available and processed DMV registration data, and VMT estimates from regional transportation planning agencies. EMFAC2011-LDV estimates emissions for six vehicle classes that would be regulated under the proposed Rule, as shown in Table 2-1.

Table 2-1: Light Duty Vehicle Categories

Vehicle Type	Abbreviation	Gross Vehicle Weight Rating, lb	Curb Weight, lb
Passenger Car	PC or LDA		
Light Duty Truck 1	LT1	< 6000	<3450
Light Duty Truck 2	LT2	< 6000	>3450
Medium Duty Vehicle	LT3 / MDV	6000 - 8500	
Medium Duty Truck 4	MT4 / LHDT1	8500 – 10,000	
Medium Duty Truck 5	MT5 / LHDT2	10,000 – 14,000	

In the EMFAC model, emissions are calculated as the product of a population of vehicles, the number of miles traveled per vehicle, and emission rates for each vehicle per mile. This calculation is complex, accounting for the different technologies with each model year and vehicle class; the deterioration of emission rates over time and miles driven; the difference in miles driven by vehicle class and age; and many other factors.

EMFAC2011 was used as the starting point for analyzing emissions for this proposed regulation. To conduct the regulatory analysis, staff used EMFAC2011-LDV output to develop a series of databases that were used to assess statewide average emissions under different baseline and regulatory scenarios. Using the database allowed for the creation of multiple alternative regulatory scenarios in a more transparent way and without the need for reprogramming EMFAC. The methodology used to develop each scenario is based on the following equation:

$$\text{Emissions} = \text{POP} \times \text{TECH} \times \text{ACCRL} \times \text{EF}$$

where

POP	Population of a vehicle of a given vehicle type and model year
TECH	The technology fraction (tech fraction) is the fraction of vehicles which meets the different emission exhaust standard categories, such as super ultra-low emission vehicle (SULEV), or ultra-low emissions vehicle (ULEV).
ACCRL	The annual miles that vehicles travel in a given year
EF	A measure of the amount of pollutant released per mile of travel

EMFAC2011-LDV output was separated into these components for each vehicle class, each model year (or age) and each calendar year of interest. The baseline inventory was calculated using EMFAC2011, and incorporated a few baseline adjustments focused on reflecting our latest assessment of baseline technology penetration into the future, and on the latest available data relevant to PM emission factors. Because EMFAC2011 estimates emissions to 2035, staff also developed a long-term forecast to estimate emissions from 2035 to 2050. Benefits of the proposed regulation were calculated as the difference between the baseline inventory and regulatory scenario inventories.

EMFAC2011-LDV outputs emissions for reactive organic gases (ROG or NMOG), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and oxides of nitrogen (NO_x).

2.2 Base Emissions Inventory

EMFAC2011-LDV is the source of base emissions data for the ACC mobile source emissions inventory database (ARB, 2011c). EMFAC2011-LDV is an updated version of EMFAC2007 which covers the vehicle classes that would be covered under the proposed regulation. The model contains multiple relevant updates including:

- Updated population from analysis of California Department of Motor Vehicles databases, using updated methodologies based on modern Vehicle Identification Number (VIN) decoders;
- Updated VMT estimates provided by regional transportation planning agencies;
- Updated carbon dioxide emission rates to better account for air conditioning use, and oxygenated fuels;
- Updated minor corrections to evaporative emissions calculations;
- Updated brake wear PM emission factors to account for modern brake materials; and
- Updated gasoline PM exhaust emission factors based on recent test data.

More information on these updates is available in ARB (2011b).

EMFAC2011-LDV reflects the long-term impact of the recent economic recession on VMT growth forecasts, but is not designed to reflect the short-term economic cycle (ARB, 2011a). VMT growth rates and forecast new vehicle sales reflect average trends given smooth, depressed growth in light of the economic recession, and do not reflect recent sales declines due to the recent recession.

The Advanced Clean Cars (ACC) mobile source emissions inventory database is based upon EMFAC2011-LDV .bdn inventory output. The statewide inventory was run as statewide annual average, by calendar year, model year, vehicle class, fuel, and technology group. That inventory report provides emissions by process and pollutant.

Statewide emissions data were processed from a single file into multiple input files for the database. A population table was developed reflecting the population by vehicle class by calendar year, model year, and fuel across all tech groups. A technology fraction table was developed by calculating the population ratio in each technology group by calendar year, model year, vehicle class, and fuel. A mileage accrual table was developed by calculating VMT/population by calendar year, model year, vehicle class, and fuel. Finally, an emission factor table was calculated by calculating emissions/VMT for each calendar year, vehicle class, model year, technology group, fuel, and process. Emission factors were given units of g/mile for exhaust and running emissions; and g/vehicle-day for evaporative, start, and idling emissions. The product of these four tables generates the same emissions as originally output from EMFAC2011-LDV. The use of this method in the ACC mobile source emissions inventory database allowed for multiple scenarios by changing technology fractions, accrual rates, or other inputs.

The use of the database approach on a statewide basis has two minor consequences. First, all calculations are performed on statewide average output, not statewide by sub-area. This generates a slightly different emissions inventory than if it had been calculated by sub-area because summing regional inventories that are based on different temperature and humidity profiles is different than the statewide temperature and humidity profiles. Second, calculating emission factors from inventory data limits the ability to assess the impact of changing accrual rates on deteriorated emissions. But because the changes in mileage accrual are small the resulting changes in deteriorated emission rates are also small.

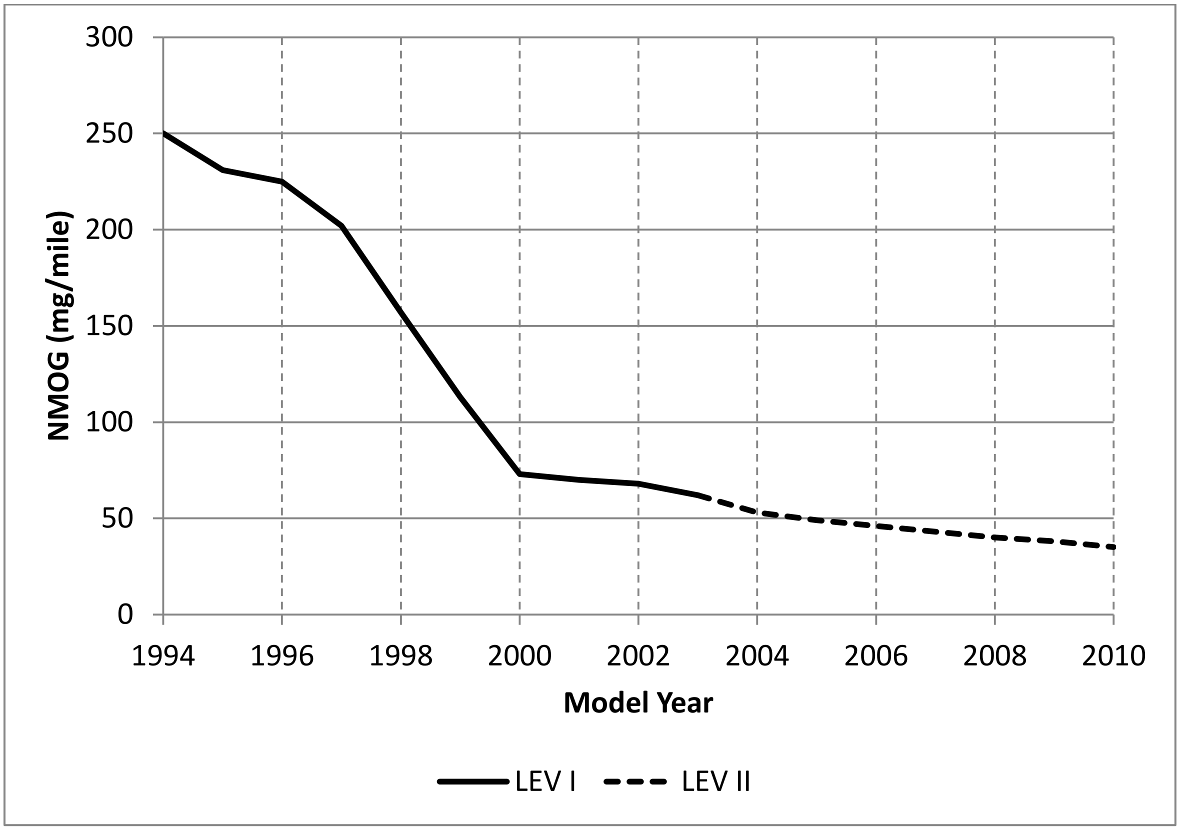
Regional emissions were run by calendar year, model year, vehicle class, fuel, and sub-area. Due to the computational intensity of calculating the inventories for adjusted baseline, the proposed regulation, and alternative regulation scenarios, staff developed statewide control factors by calendar year, vehicle class, fuel, and model year. These control factors were applied by pollutant to calculate scenario specific emissions.

In this inventory we estimate emissions for vehicle classes listed in Table 2-1. Because of uncertainties in evaporative emission factors in the light-heavy truck categories, benefits of the proposed regulation are estimated only for exhaust emissions, and not ROG emissions generated through evaporative processes.

2.2.A Emissions Standards in the Baseline Inventory

EMFAC2011-LDV reflects currently adopted emissions standards including the Low Emission Vehicle (LEV) –I and II regulations. The LEV-I standards applied to 1994-2003 model years, and LEV-II standards applied to 2004 and newer vehicles. Both regulations set multiple emissions certification levels for NMOG, NOx, and CO within each vehicle class. NMOG fleet average standards (on the Federal Test Procedure certification cycle) were established by calendar year, and vehicle manufacturers were required to certify a mix of vehicles within each vehicle class that complied with the overall NMOG fleet average requirement, as shown in Figure 2-1. In 2006 a PM emissions standard of 10 mg/mile was applied to gasoline vehicles.

Figure 2-1: Average NMOG Exhaust Emission Standards for PCs and LT1s



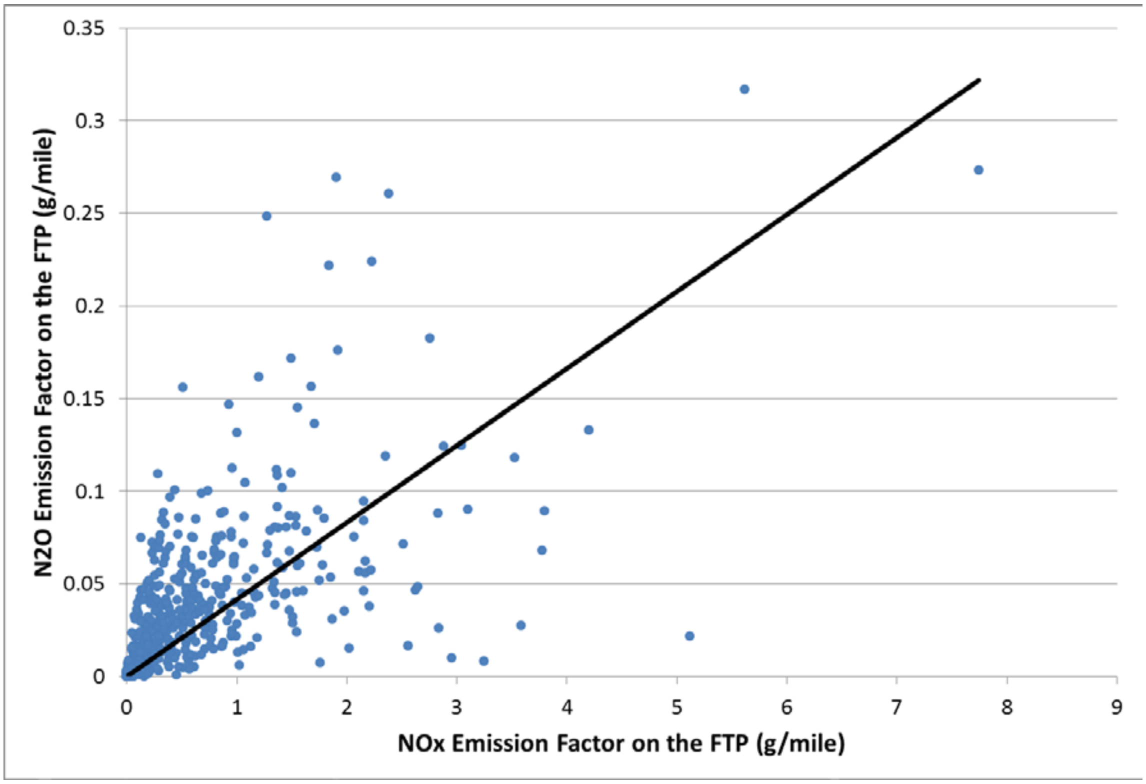
EMFAC2011-LDV contains historical technology splits reflecting certification data that described how vehicle manufacturers met the LEV I and II requirements, and reflecting ZEV penetration. More information is available EMFAC2011 Technical Documentation (ARB, 2011b).

2.2.B Nitrous Oxide in the Baseline Inventory

N_2O emissions are produced by gasoline vehicles, and have been found to be higher from catalyst-equipped vehicles than vehicles without catalytic converters. Previous studies identified a number of factors that influence N_2O emission rates including catalyst characteristics (type, age temperature) and driving characteristics (driving cycle) (Behrentz et al., 2004; Graham et al., 2009). Many of these previous analyses were developed using data from gasoline vehicles that were tested as part of the ARB's Vehicle Surveillance Projects (VSPs) at the Haagen-Smit Laboratory in El Monte, California. The purpose of these emissions testing efforts were to gain a better understanding of the factors that lead to the formation of N_2O, and to develop applicable emission factors that can be used to develop an emissions inventory.

Staff used a linear correlation approach to develop N2O emission rates. A total of 173 vehicles tested in ARB Surveillance Programs 2S00C1, 2S03C1 and 2S06C1, were used to determine a relationship between N20 and NOX across all vehicle classes and technology types. The analysis suggested that on average N2O emissions per mile are about 4 percent of total NOx emissions per mile, as shown in Figure 2-2.

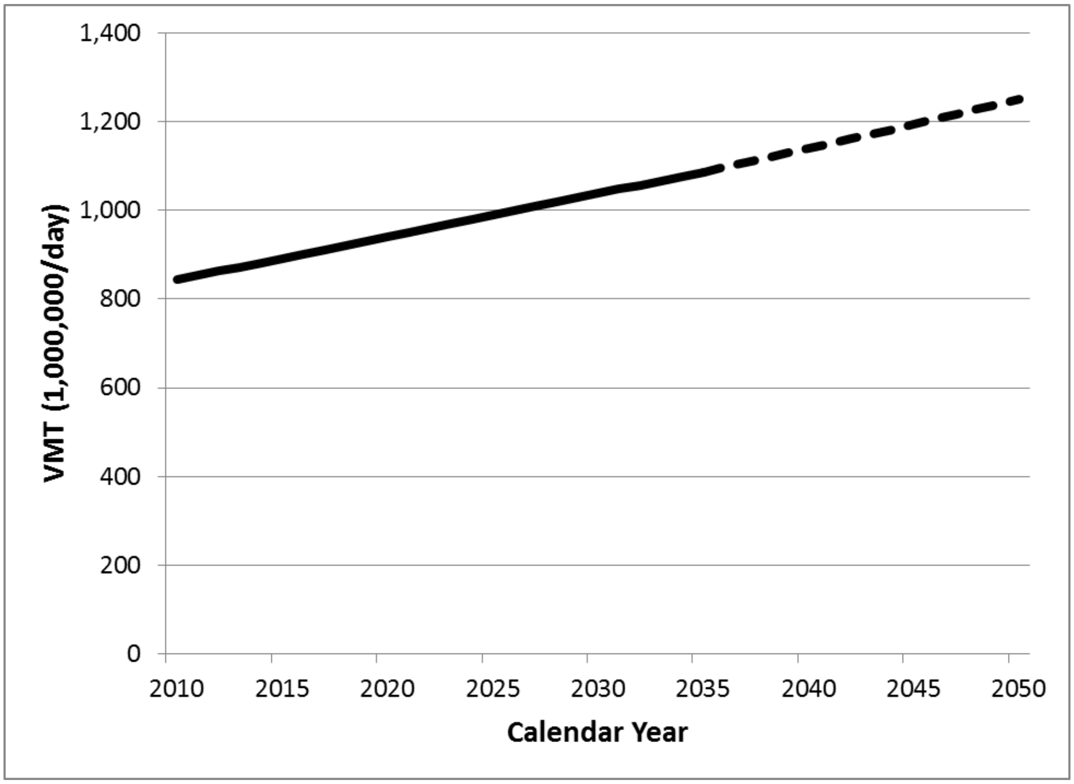
Figure 2-2. N_2O and NOx Emissions Correlation in Vehicle Tests



2.3 Forecasting 2035 – 2050

In order to forecast VMT from 2035 to 2050, staff analyzed the statewide population growth factors embedded in EMFAC2011-LDV module. Staff then applied the annual population growth rate in the last available year (2034-2035) to subsequent years to forecast the 2035 population for every year out to 2050. The resulting population forecast was coupled with the default survival rates and annual VMT accrual data used in EMFAC2011-LDV to calculate the total VMT. Figure 2-3 shows the estimated VMT forecast for cars, light trucks, and medium-duty trucks less than 8,500 pounds gross vehicle rated weight. It should be noted that this forecast is not intended to represent regional forecasts that could be developed by regional transportation planning agencies.

Figure 2-3. Passenger Car, Light Truck, and Medium-Duty Truck (<8,500 Pounds Gross Vehicle Rated Weight) Combined VMT Forecast: 2035 to 2050



2.4 Criteria Pollutant Baseline Adjustments

In the process of evaluating EMFAC2011-LDV output in preparation for developing the ACC emissions inventory, staff identified several factors that needed to be updated in the baseline emissions inventory, prior to assessing the benefits of the proposed regulation. These improvements are expressed through the ACC emissions inventory database as adjustments to the base EMFAC2011-LDV emissions inventory output.

2.4.A.1 Population and Technology Penetration

EMFAC2011 included an assessment of technology penetration to meet LEV-I, LEV-II, and adopted ZEV rules. For this assessment staff evaluated manufacturer compliance data on technology penetration by model year and vehicle staff. As a result staff increased the historical penetration of MDV diesel vehicles and reduced the penetration ZEVs and near zero evaporative technologies. These updates more properly reflected technology penetration but had no impact on estimated fleet average emission rates, since staff assumed manufacturers would comply with adopted regulations. In essence manufacturers complied with regulations in a slightly different but equally effective manner than staff previously anticipated, and updates more accurately reflect the mix of technologies that were and would be sold into the fleet barring additional regulation.

In the EMFAC model technology groups are assigned a code number, and technology penetration splits are estimated by vehicle class and process (exhaust vs evaporative) across both gasoline and diesel vehicles. Table 2-2 provides a definition for each technology group that is applied to vehicle categories included in the ACC mobile source emissions inventory database. In evaporative technology groups, the certification standard is in the form of total emissions limit / fuel related emissions limit.

Table 2-2. Technology Group Definitions by EMFAC Code Number

Technology Group	Emission Group Name	Certification Standard	Fuel	Vehicle Types
EV011	Pre Enhanced FI		Gasoline	PC
EV014	Enhanced Evap OBD2	2000 mg/d	Gasoline	PC
EV015	Near Zero OBD2	500 mg/d	Gasoline	PC
EV016	ZEV		Gasoline	PC
EV017	Zero Evap	350/54 mg/d	Gasoline	PC
EV035	Near Zero Evap	650 mg/d	Gasoline	LT1, LT2
EV036	ZEV		Gasoline	LT1, LT2
EV037	Zero Evap	500/54 mg/d	Gasoline	LT1, LT2
EV038	LEV 3 Evap	750/54 mg/d	Gasoline	LT3, MT4, MT5
EV039	ZEV		Gasoline	LT3
EX025	ZEV		Gasoline	PC, LT1, LT2, LT3
EX028	L2 LEV	160 mg/mi	Gasoline	PC, LT1, LT2, LT3
EX029	L2 ULEV	125 mg/mi	Gasoline	PC, LT1, LT2, LT3
EX030	SULEV	30 mg/mi	Gasoline	PC, LT1, LT2, LT3
EX031	PZEV	30 mg/mi	Gasoline	PC, LT1, LT2, LT3
EX037	AT PZEV	30 mg/mi	Gasoline	PC, LT1, LT2, LT3
EX038	SULEV20	20 mg/mi	Gasoline, Diesel	PC, LT1, LT2, LT3
EX039	ULEV50	50 mg/mi	Gasoline, Diesel	PC, LT1, LT2, LT3
EX043	81+ Mexican 0.7 NOx		Gasoline	PC
EX044	ULEV70	70 mg/mi	Gasoline, Diesel	PC, LT1, LT2, LT3
EX054	08+ EPA HDG	340 mg/hp-h	Gasoline	MT4
EX056	L2 LEV	395 mg/mi	Gasoline, Diesel	MT4
EX057	ULEV340	340 mg/mi	Gasoline	MT4
EX058	ULEV250	250 mg/mi	Gasoline	MT4
EX059	SULEV170	170 mg/mi	Gasoline	MT4
EX071	08+ EPA HD	340 mg/hp-h	Diesel	MT4
EX072	ULEV340	340 mg/mi	Diesel	MT4

Technology Group	Emission Group Name	Certification Standard	Fuel	Vehicle Types
EX073	ULEV250	250 mg/mi	Diesel	MT4
EX074	SULEV170	170 mg/mi	Diesel	MT4
EX084	08+ EPA HDG	340 mg/hp-h	Gasoline	MT5
EX085	ULEV570	570 mg/mi	Gasoline	MT5
EX086	ULEV400	400 mg/mi	Gasoline	MT5
EX087	SULEV230	230 mg/mi	Gasoline	MT5
EX101	08+ EPA HD	340 mg/hp-h	Diesel	MT5
EX102	L2 LEV	630 mg/mi	Diesel	MT5
EX103	ULEV570	570 mg/mi	Diesel	MT5
EX104	ULEV400	400 mg/mi	Diesel	MT5
EX105	SULEV230	230 mg/mi	Diesel	MT5
EX177	93-03 DSL		Diesel	PC, LT1, LT2, LT3
EX178	L2 LEV	160 mg/mi	Diesel	PC, LT3
EX179	L2 ULEV	125 mg/mi	Diesel	PC, LT3

Table 2-3, Table 2-4, Table 2-5, Table 2-6, Table 2-7, and Table 2-8 provide population splits by technology group for each regulated vehicle class in the adjusted baseline.

Table 2-3. Adjusted Baseline Technology Splits for Passenger Cars (Fraction of Total by Model Year)

Baseline Technology Fractions for Passenger Cars (PC or LDA)														
Calendar Year	Ev011	Ev015	Ev016	Ev017	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex043	Ex044	Ex178	Ex179
	Evaporative				Exhaust									
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel	Diesel
2010	0.005	0.784	0.001	0.210	0.001	0.050	0.731	0.210			0.001		0.250	0.750
2011	0.019	0.771	0.001	0.210	0.001	0.050	0.731	0.210			0.001		0.250	0.750
2012	0.011	0.777	0.002	0.210	0.009	0.050	0.723	0.210			0.001		0.250	0.750
2013	0.013	0.775	0.002	0.210	0.010	0.050	0.722	0.210			0.001		0.250	0.750
2014		0.788	0.002	0.210	0.010	0.050	0.722	0.210			0.001		0.250	0.750
2015		0.782	0.008	0.210	0.019	0.050	0.713	0.210			0.001		0.250	0.750
2016		0.782	0.009	0.210	0.020	0.050	0.712	0.210			0.001		0.250	0.750
2017		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2018		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2019		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2020		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2021		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2022		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2023		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2024		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2025		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2026		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2027		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2028		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2029		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2030		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2031		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2032		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2033		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2034		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750
2035		0.781	0.009	0.210	0.020	0.050	0.711	0.210			0.001		0.250	0.750

Table 2-4. Adjusted Baseline Technology Splits for Light Truck 1 (Fraction of Total by Model Year)

Baseline Technology Fractions for Light Duty Trucks (LDT1)									
Calendar Year	Ev035	Ev036	Ev037	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039
	Evaporative			Exhaust					
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
2010	0.790	0.000	0.210		0.050	0.740	0.210		
2011	0.790	0.000	0.210		0.050	0.740	0.210		
2012	0.789	0.001	0.210		0.050	0.740	0.210		
2013	0.789	0.002	0.210		0.050	0.740	0.210		
2014	0.789	0.002	0.210		0.050	0.740	0.210		
2015	0.784	0.006	0.210		0.050	0.740	0.210		
2016	0.784	0.006	0.210		0.050	0.740	0.210		
2017	0.784	0.006	0.210		0.050	0.740	0.210		
2018	0.784	0.006	0.210		0.050	0.740	0.210		
2019	0.784	0.006	0.210		0.050	0.740	0.210		
2020	0.784	0.006	0.210		0.050	0.740	0.210		
2021	0.784	0.006	0.210		0.050	0.740	0.210		
2022	0.784	0.006	0.210		0.050	0.740	0.210		
2023	0.784	0.006	0.210		0.050	0.740	0.210		
2024	0.784	0.006	0.210		0.050	0.740	0.210		
2025	0.784	0.006	0.210		0.050	0.740	0.210		
2026	0.784	0.006	0.210		0.050	0.740	0.210		
2027	0.784	0.006	0.210		0.050	0.740	0.210		
2028	0.784	0.006	0.210		0.050	0.740	0.210		
2029	0.784	0.006	0.210		0.050	0.740	0.210		
2030	0.784	0.006	0.210		0.050	0.740	0.210		
2031	0.784	0.006	0.210		0.050	0.740	0.210		
2032	0.784	0.006	0.210		0.050	0.740	0.210		
2033	0.784	0.006	0.210		0.050	0.740	0.210		
2034	0.784	0.006	0.210		0.050	0.740	0.210		
2035	0.784	0.006	0.210		0.050	0.740	0.210		

Table 2-5. Adjusted Baseline Technology Splits for Light Truck 2 (Fraction of Total by Model Year)

Baseline Technology Fractions for Light Duty Trucks (LDT2)									
Calendar Year	Ev035	Ev036	Ev037	Ex025	Ex028	Ex029	Ex039	Ex044	Ex178
	Evaporative			Exhaust					
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel
2010	1.000	0.000			0.040	0.960			1.000
2011	1.000	0.000			0.040	0.960			1.000
2012	1.000	0.000			0.040	0.960			1.000
2013	1.000	0.000			0.040	0.960			1.000
2014	1.000	0.000			0.040	0.960			1.000
2015	0.999	0.001			0.040	0.960			1.000
2016	0.999	0.001			0.040	0.960			1.000
2017	0.999	0.001			0.040	0.960			1.000
2018	0.999	0.001			0.040	0.960			1.000
2019	0.999	0.001			0.040	0.960			1.000
2020	0.999	0.001			0.040	0.960			1.000
2021	0.999	0.001			0.040	0.960			1.000
2022	0.999	0.001			0.040	0.960			1.000
2023	0.999	0.001			0.040	0.960			1.000
2024	0.999	0.001			0.040	0.960			1.000
2025	0.999	0.001			0.040	0.960			1.000
2026	0.999	0.001			0.040	0.960			1.000
2027	0.999	0.001			0.040	0.960			1.000
2028	0.999	0.001			0.040	0.960			1.000
2029	0.999	0.001			0.040	0.960			1.000
2030	0.999	0.001			0.040	0.960			1.000
2031	0.999	0.001			0.040	0.960			1.000
2032	0.999	0.001			0.040	0.960			1.000
2033	0.999	0.001			0.040	0.960			1.000
2034	0.999	0.001			0.040	0.960			1.000
2035	0.999	0.001			0.040	0.960			1.000

Table 2-6. Adjusted Baseline Technology Splits for Medium Duty Vehicles (Fraction of Total by Model Year)

Baseline Technology Fractions for Medium Duty Vehicles (MDV)								
Calendar Year	Ev035	Ev036	Ev038	Ex025	Ex028	Ex029	Ex178	Ex179
	Evaporative			Exhaust				
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel	Diesel
2010	1.000	0.000			0.154	0.846	0.250	0.750
2011	1.000	0.000			0.154	0.846	0.250	0.750
2012	1.000	0.000			0.154	0.846	0.250	0.750
2013	1.000	0.000			0.154	0.846	0.250	0.750
2014	1.000	0.000			0.154	0.846	0.250	0.750
2015	0.999	0.001			0.154	0.846	0.250	0.750
2016	0.999	0.001			0.154	0.846	0.250	0.750
2017	0.999	0.001			0.154	0.846	0.250	0.750
2018	0.999	0.001			0.154	0.846	0.250	0.750
2019	0.999	0.001			0.154	0.846	0.250	0.750
2020	0.999	0.001			0.154	0.846	0.250	0.750
2021	0.999	0.001			0.154	0.846	0.250	0.750
2022	0.999	0.001			0.154	0.846	0.250	0.750
2023	0.999	0.001			0.154	0.846	0.250	0.750
2024	0.999	0.001			0.154	0.846	0.250	0.750
2025	0.999	0.001			0.154	0.846	0.250	0.750
2026	0.999	0.001			0.154	0.846	0.250	0.750
2027	0.999	0.001			0.154	0.846	0.250	0.750
2028	0.999	0.001			0.154	0.846	0.250	0.750
2029	0.999	0.001			0.154	0.846	0.250	0.750
2030	0.999	0.001			0.154	0.846	0.250	0.750
2031	0.999	0.001			0.154	0.846	0.250	0.750
2032	0.999	0.001			0.154	0.846	0.250	0.750
2033	0.999	0.001			0.154	0.846	0.250	0.750
2034	0.999	0.001			0.154	0.846	0.250	0.750
2035	0.999	0.001			0.154	0.846	0.250	0.750

Table 2-7. Adjusted Baseline Technology Splits for Light Heavy Truck 1 (Fraction of Total by Model Year)

Baseline Technology Fractions for Light Heavy Duty Trucks (LHD1)		
Calendar Year	Ex054	Ex071
	Exhaust	
	Gasoline	Diesel
2010	1.000	1.000
2011	1.000	1.000
2012	1.000	1.000
2013	1.000	1.000
2014	1.000	1.000
2015	1.000	1.000
2016	1.000	1.000
2017	1.000	1.000
2018	1.000	1.000
2019	1.000	1.000
2020	1.000	1.000
2021	1.000	1.000
2022	1.000	1.000
2023	1.000	1.000
2024	1.000	1.000
2025	1.000	1.000
2026	1.000	1.000
2027	1.000	1.000
2028	1.000	1.000
2029	1.000	1.000
2030	1.000	1.000
2031	1.000	1.000
2032	1.000	1.000
2033	1.000	1.000
2034	1.000	1.000
2035	1.000	1.000

Table 2-8. Adjusted Baseline Technology Splits for Light Heavy Truck 2 (Fraction of Total by Model Year)

Baseline Technology Fractions for Light Heavy Duty Trucks (LHD2)		
Calendar Year	Ex084	Ex101
	Exhaust	
	Gasoline	Diesel
2010	1.000	1.000
2011	1.000	1.000
2012	1.000	1.000
2013	1.000	1.000
2014	1.000	1.000
2015	1.000	1.000
2016	1.000	1.000
2017	1.000	1.000
2018	1.000	1.000
2019	1.000	1.000
2020	1.000	1.000
2021	1.000	1.000
2022	1.000	1.000
2023	1.000	1.000
2024	1.000	1.000
2025	1.000	1.000
2026	1.000	1.000
2027	1.000	1.000
2028	1.000	1.000
2029	1.000	1.000
2030	1.000	1.000
2031	1.000	1.000
2032	1.000	1.000
2033	1.000	1.000
2034	1.000	1.000
2035	1.000	1.000

2.4.A.2 Exhaust PM Emission Factors

Gasoline PM emission factors were updated for EMFAC2011-LDV using data from several test programs (ARB, 2011b). Staff identified that PM emission factors from 1996 and newer vehicles were substantially cleaner than previously estimated. In addition, staff found, based on testing on the federal test procedure and unified cycles, that PM emission factors for 2004 and newer port-fuel injected (PFI) vehicles were much lower (<1 mg/mile) than similar vehicles manufactured between 1996 and 2003 (4 mg/mile). Staff also found that gasoline direct injection (GDI) engines had higher PM emissions (~4 mg/mile) than port fuel injection engines of similar age (<1 mg/mile). Table 2-9 shows the gasoline PM emission factors assumed in EMFAC2011-LDV.

Table 2-9. Gasoline PM Emission Factors in EMFAC2011-LDV

MY / Tech-Group	UC Bag 2 (Hot Stabilized) (mg/mile)	UC Bag 1 (Start) (mg/mile)
Pre-1981	64	294
1981-1990	25	106
1991-1995	14	35
1996-2003	4	23
2004+ PFI	0.3	0.9
2007+ GDI (wall)	3.6	39

In August 2011, after EMFAC2011-LDV was finalized, staff received summary results from 17 newly tested vehicles conducted by U.S. EPA on LEV-II certified vehicles. All vehicles were tested on the federal test procedure and the US06 test cycle. Adding the new federal test procedure results from U.S. EPA to the results from the previous test program more than doubled the average emission factor from 0.5 mg/mile to 1.2 mg/mile. Of the 17 newly tested vehicles 5 were identified as oil burning vehicles and had apparently higher test results than other vehicles tested by U.S. EPA (2.7 mg/mile for oil burners vs 0.5 mg/mile for non-oil burners). In addition, results on the US06, while not statistically significant, suggested that newer port fuel injected vehicles (average 10 mg/mile on USO6) may have less precise fuel injection under aggressive driving conditions and therefore higher emission factors, than gasoline direct injection technology engines (2 mg/mile on the US06).

Taken together, these new test data suggested some port fuel injected engines may deteriorate and begin burning oil as they age. In addition, those same port fuel injected engines may not be as well controlled under aggressive driving conditions than test results on the federal test procedure would indicate. These findings are based upon data unavailable when EMFAC2011-LDV was finalized. In light of uncertainties in the data, staff no longer felt that data were sufficiently conclusive to justify assuming a lower emission factor for 2004 and newer vs 1996-2003 port fuel injected engines for the ACC analysis. Therefore the gasoline PM emission factors were adjusted to reflect no difference between 1996-2003 and 2004 and newer port fuel injected engines and current technology gasoline direct injection engines. These updated were made to the ACC mobile source emissions inventory database tool. Changes from Table 2-9 are marked in bold in Table 2-10.

Table 2-10. Updated Gasoline PM Emission Factors

MY / Tech-Group	**UC Bag 2 (Hot Stabilized) (mg/mile)**		**UC Bag 1 (Start) (mg/mile)**	
	Previous	Proposed	Previous	Proposed
Pre-1981	64	64	294	294
1981-1990	25	25	106	106
1991-1995	14	14	35	35
1996-2003	4	4	23	23
2004+ PFI	**0.3**	**4**	**0.9**	**23**
2007+ GDI (wall)	**3.6**	**4**	**39**	**23**
3 mg/mile FTP		**3**		**16.7**
1 mg/mile FTP		**1**		**5.6**

2.5 Greenhouse Gas Baseline Adjustments

EMFAC2011-LDV does not account for the benefits of the adopted Pavley federal standard, and does not account for the Low Carbon Fuel Standard. These adjustments to the baseline are made in the ACC mobile source emissions inventory database tool.

2.5.A.1 Pavley-I Federal Standard

The EMFAC2011-LDV module of EMFAC2011 does not include the benefits of the federally adopted version of the Pavley standard. The ACC database tool calculates an adjusted baseline which includes the federal standard using the percent reductions shown in Table 2-11[1].

[1] Federal standard in California fleet mix.

Table 2-11: Federal GHG Standards

	Category	Cars[2] (g/mile)	Trucks[3] (g/mile)	Average (g/mile)	Car Reductions	Truck Reductions
Base Year	2008	291	396	336	---	--
Federal Standard	2012	263	340	290	9.6%	14.1%
	2013	256	330	283	12.0%	16.7%
	2014	248	321	275	14.8%	18.9%
	2015	236	306	263	18.9%	22.7%
	2016	226	292	251	22.3%	26.3%

2.5.A.2 Low Carbon Fuel Standard

The EMFAC2011-LDV module of EMFAC2011 does not include the benefits of the California Low Carbon Fuel Standard (LCFS). The ACC database tool adjusts the baseline inventory for the benefits of the LCFS as a percentage reduction in fossil carbon by calendar year. The percentage reduction applied in this analysis is based on the assumption that the percentage reduction from tank to wheel emissions under LCFS and the percentage reduction well to tank are equivalent. Reduction percentages are shown in Table 2-12.

2.6 Rebound

The Rebound Effect is the idea that the demand for driving is a function of the operating costs of the vehicle being driven. When operating costs increase, such as when fuel prices increase, driving becomes more expensive and people drive less. Conversely, if fuel prices decrease people may drive more. The demand for driving is a function of many factors including income, fuel prices, the distance between one's home and job, desired discretionary driving, transit options and many other factors. Regional transportation planning agencies consider all of the factors affecting travel demand when they estimate regional miles traveled for the EMFAC model. In this case the adopted Pavley federal standard will decrease vehicle operating costs by increasing the vehicle fuel efficiency. This specific effect of the adopted regulation was not accounted for in regional VMT estimates integrated into EMFAC2011-LDV.

The magnitude of the rebound effect is the subject of extensive academic research, which is briefly reviewed in Appendix S. Although the federal agencies are applying a 10 percent rebound to their analysis, ARB staff believes that California's relatively

[2] Passenger Cars (All)
[3] Trucks 0-8500 lb. Loaded Vehicle Weight

higher income and congestion levels relative to the national average justify the use of a different rebound assumption. Based on the methodology developed by Hymel et al., (2010) using California-specific inputs, ARB staff estimated future projections of the rebound effect through CY2030 for both the baseline and policy cases ranging between 3 and 6 percent depending on the year and scenario. Further details about the methodology and data used to estimate rebound levels are presented in Appendix S.

These rebound effects were then translated into the percentage change in VMT by model year and vehicle class for new vehicles sold with and without the Pavley federal standard and with and without the proposed regulation, based on the estimated percentage decrease in vehicle operating cost. The overall percentage increase in model year specific VMT ranged between one and two percent depending on the calendar year and scenario. When rebound rates were included in the inventory to reflect the Pavley federal standard, overall emissions increased negligibly, by around one percent. Increases in VMT by model year were marginally higher than one percent in the adjusted baseline and around two percent for regulatory scenarios. VMT increases were applied in the inventory calculation by model year and included in both criteria and greenhouse gas emissions inventories.

Table 2-12. Low Carbon Fuel Standard Reduction Factors

Calendar Year	Reduction Factor
2010	--
2011	0.25%
2012	0.5%
2013	1.0%
2014	1.5%
2015	2.5%
2016	3.5%
2017	5.0%
2018	6.5%
2019	8.0%
2020 +	10.0%

2.7 Criteria Pollutant Regulatory Scenarios

The proposed ACC regulation includes new future year emissions standards, and a new Zero-Emission Vehicle (ZEV) program requirement. The benefits of these regulatory features are modeled together. To comply with the proposed LEV-III and ZEV regulations, vehicle manufacturers must sell a combination of vehicles certifying to specific emissions standards that meets a fleet-wide average regulatory target in each calendar year. Different certification levels are defined for each vehicle class. To meet fleet average emissions targets, engine manufacturers are expected to increase control of air-fuel ratios in their engines and improve catalysts to increase control efficiency. Two scenarios were considered for the ACC initiative. In this section these are referred to as the proposed scenario, and the accelerated scenario.

2.7.A New Technology Groups

Several new certification levels have been defined in the emissions inventory as potential compliance paths for manufacturers in meeting the proposed standard and the accelerated scenario. The proposed LEV-III program creates ULEV (Ultra-low emission vehicles) and SULEV emission levels in selected vehicle classes for which no testing data are available. To express these new technology groups in the ACC emissions inventory database, staff used a ratio of standards approach. A ratio of standards approach is a technique used to estimate emission factors where no test data are available. For example, if test exhaust test data are available for ULEV 50 automobiles but not for SULEV 20 automobiles, unified cycle emission factors in EMFAC for the ULEV category would be multiplied by the ratio of standards, in this case 20 mg/mi for SULEV 20 divided by 50 mg/mi for ULEV 50 to estimate SULEV 20 emission factors. These technology groups and their emission rates are shown in Table 2-13, Table 2-14, and Table 2-15. Table 2-16 provides the equations used to calculate emission factors for new technology groups using the ratio of standards approach.

Table 2-13. Proposed Automobile and Light Truck Technology Groups, NMOG+NOx Emission Rates (mg/mile – FTP Composite)

Category	Emissions Level (mg/mi)
LEV	160
ULEV	125
ULEV 70	70
ULEV 50	50
SULEV	30
SULEV 20	20

Table 2-14. Proposed Light-Heavy Duty-1 (MT4) Technology Groups, NMOG+NOx Emission Rates (mg/mile – FTP Composite)

Category	Emissions Level (mg/mi)
LEV	395
ULEV	340
ULEV250	250
SULEV170	170

Table 2-15. Proposed Light-Heavy Duty-2 (MT5) Technology Groups, NMOG+NOx Emission Rates (mg/mile – FTP Composite)

Category	Emissions Level (mg/mi)
LEV	630
ULEV	570
ULEV400	400
SULEV230	230

Table 2-16. Emission Factor Assumptions for New Technology Groups

Technology Group	Emission Group Name	Certification Standard	Fuel	Vehicle Types	ROG, TOG, CH4, NOX	CO	Diurnal, Resting	Hotsoak	Running
EV016	ZEV		Gasoline	PC			Ev17(1)	0	0
EV036	ZEV		Gasoline	LT1, LT2			Ev37(1)	0	0
EV038	LEV 3 Evap	750/54 mg/d	Gasoline	MDV-LHD2			Ev37*7.5/5	Ev37*7.5/5	EV 37
EV039	ZEV		Gasoline	LT3			Ev37*7.5/5	0	0
EX038	SULEV20	20 mg/mi	Gasoline,	PC-MDV	Ex 31*2/3	Ex 31			
EX039	ULEV50	50 mg/mi	Gasoline,	PC-MDV	Ex 29*5/12.5	Ex 29			
EX044	ULEV70	70 mg/mi	Gasoline,	PC-MDV	Ex 29*7/12.5	Ex 29			
EX057	ULEV340	340 mg/mi	Gasoline	MT4	Ex 54	Ex 54			
EX058	ULEV250	250 mg/mi	Gasoline	MT4	Ex 54*2.5/3.4	Ex 54			
EX059	SULEV170	170 mg/mi	Gasoline	MT4	Ex 54*1.7/3.4	Ex 54			
EX072	ULEV340	340 mg/mi	Diesel	MT4	Ex 54	Ex 71			
EX073	ULEV250	250 mg/mi	Diesel	MT4	Ex 54*2.5/3.4	Ex 71			
EX074	SULEV170	170 mg/mi	Diesel	MT4	Ex 54*1.7/3.4	Ex 71			
EX085	ULEV570	570 mg/mi	Gasoline	MT5	Ex84	Ex 84			
EX086	ULEV400	400 mg/mi	Gasoline	MT5	Ex 54*2.5/3.4	Ex 84			
EX087	SULEV230	230 mg/mi	Gasoline	MT5	Ex 54*1.7/3.4	Ex 84			
EX103	ULEV570	570 mg/mi	Diesel	MT5	Ex 84	Ex101			
EX104	ULEV400	400 mg/mi	Diesel	MT5	Ex 54*2.5/3.4	Ex101			
EX105	SULEV230	230 mg/mi	Diesel	MT5	Ex 54*1.7/3.4	Ex101			
EX178	L2 LEV	160 mg/mi	Diesel	PC, LT3	Ex 28	Ex177			
EX179	L2 ULEV	125 mg/mi	Diesel	PC, LT3	Ex 29	Ex177			

2.7.B Proposed Criteria Pollutant Regulatory Scenario

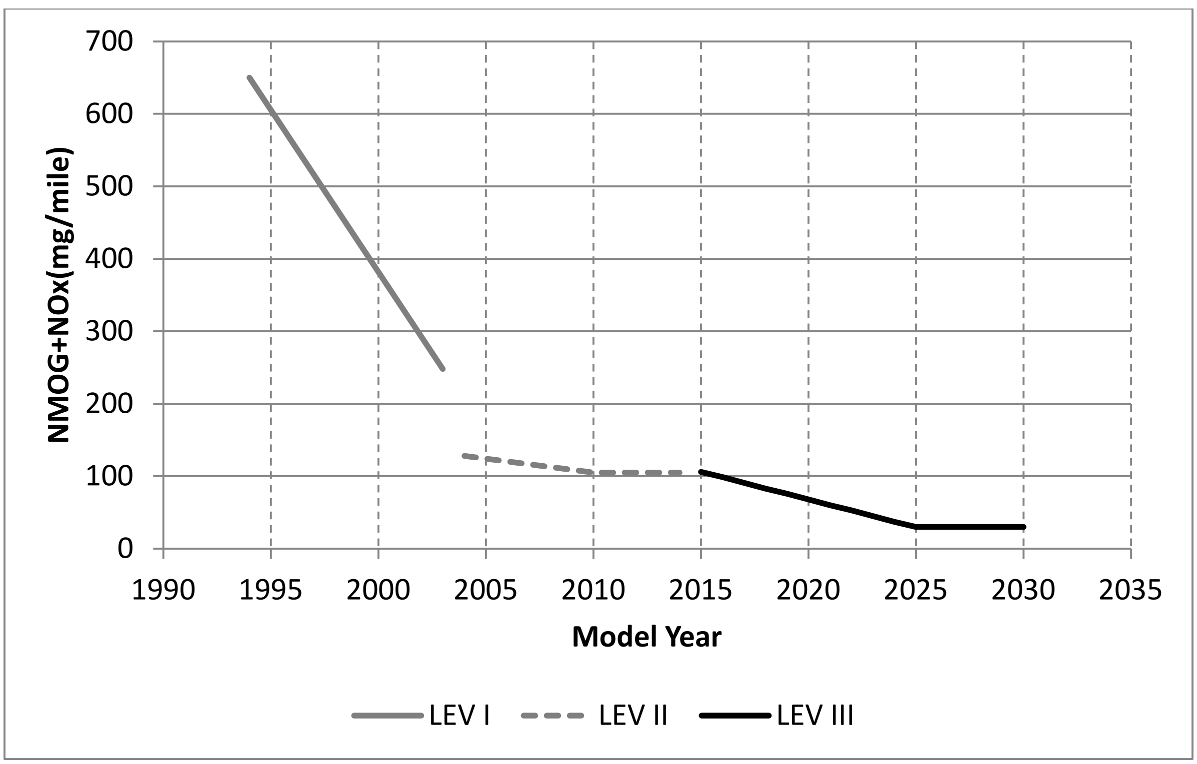
To estimate compliance under the proposed regulatory scenario, staff estimated how automakers would comply with the proposed standards at the technology level. Staff assumed technology penetration rates that reflect a likely compliance scenario, but there are many possible sales split schedules which satisfy the fleet standards.

The LEV-III program would require manufacturers to meet an average SULEV (30 mg/mi) exhaust emissions levels across their fleet of passenger cars and trucks up to 8,500 pounds gross vehicle rated weight in 2025. Manufacturers are allowed to sell vehicles meeting different certification levels so long as their fleet average emissions meet the standard level. Table 2-17 shows the proposed standards in tabular format; Figure 2-4 shows the same information in graphical format. Exhaust emissions standards would be substantially more stringent under the proposed regulation.

Table 2-17. Proposed LEV-III NMOG + NOx Fleet Average Emissions Standard for Automobiles and Light Trucks Less Than 8,500 Pounds Gross Vehicle Rated Weight

Model year	Proposed Standard (mg/mi)
2014	113
2015	106
2016	99
2017	91
2018	83
2019	76
2020	68
2021	60
2022	53
2023	45
2024	37
2025	30

Figure 2-4: Proposed LEV III Standards NMOG+NOX



For evaporative emissions, the LEV-III regulation requires that all light duty vehicles meet the zero-evaporative emissions level (<54 mg/d diurnal which rounds to 0.0 g/d) by 2022. Previously, under the LEV-II regulation this emissions level was voluntary. Table 2-18 provides the proposed phase-in schedule.

Table 2-18: Proposed LEV-III Evaporative Emissions Phase-In Schedule for Light Duty Vehicles

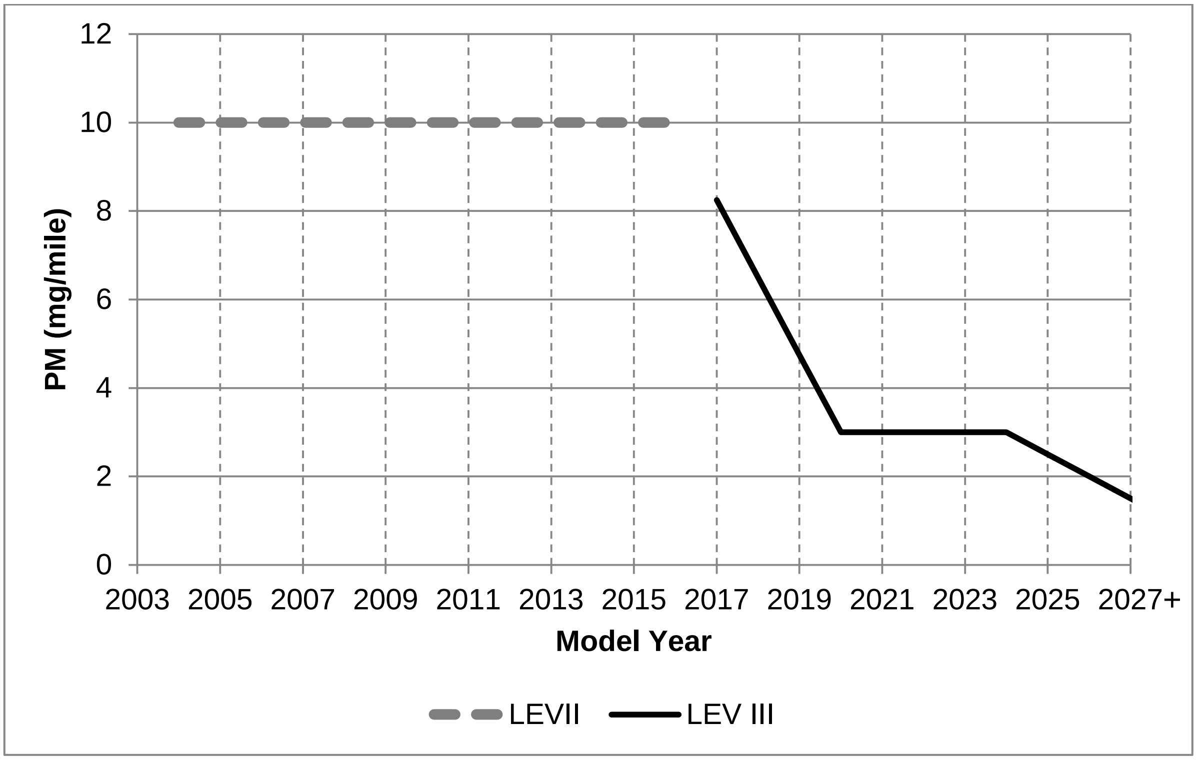
Model Year	Percent of New Vehicles Sold Meeting Zero-Evaporative Emissions Requirements
2018	60
2019	60
2020	80
2021	80
2022	100

The current LEV-II emissions standard for particulate matter is 10 mg/mi and has been in place since 2006. Under the proposed LEV-III program, the standards are proposed to be reduced by an order of magnitude by 2028. The phase-in schedule for the new standard is shown in tabular format in Table 2-19 and graphically in Figure 2-5.

Table 2-19: Proposed Gasoline PM Exhaust Standards

Model Year	Proposed Particulate Matter Emission Standard (mg/mi)
2016	10
2017	8.25
2018	6.5
2019	4.75
2020	3
2021	3
2022	3
2023	3
2024	3
2025	2.5
2026	2
2027	1.5
2028	1

Figure 2-5: Proposed LEV III Gasoline PM Standards



The Zero Emission Vehicle (ZEV) program was adopted in 1990 and designed to develop and accelerate penetration of ZEVs into the California fleet to meet ambient ozone emissions standards. Over time, the Board modified the ZEV regulation to allow vehicle manufacturers to sell a broader range of near-zero emission vehicles instead of manufacturing pure ZEVs. Very low emission gasoline vehicles, meeting partial ZEV (PZEV 30 mg/mi exhaust from a conventional gasoline vehicle with zero evaporative emissions) or advanced technology PZEV (PZEV with improved fuel efficiency like a hybrid powertrain)) were sold instead of pure ZEVs in California and these technologies are reflected in EMFAC2011. True ZEVs, such as battery-electric vehicles and fuel cell vehicles have been demonstrated over the past decade and today several true ZEVs are available for sale in California.

In the emissions inventory, ZEV technology fractions include both true ZEVs, such as battery electric or fuel cell vehicles, and plug-in-hybrids that are assumed to spend on average 40 percent of their time operating solely on electric power. As shown in Table 2-20, the proposed ZEV amendments begin in 2018, when true ZEV sales are required to be one percent of overall automobile and light truck vehicle sales. Staff assumes that in 2018 one percent of all vehicles sold will be true ZEVs, and in addition an additional two percent ZEV equivalents (or 5 percent of all vehicles at 40 percent ZEV mileage) will be sold in the form of plug-in hybrid vehicles to comply with LEV-III requirements.

Ultimately the proposed regulation would require 6 percent of all vehicles sold by 2025 to be true zero emission vehicles, and staff assumes an additional 4percent ZEV equivalent plug-in-hybrids will also be sold to meet LEV-III requirements, for a total of 10 percent ZEV equivalent sales in 2025.

Table 2-20: Assumed Fraction of Total Automobile and Light Truck New Vehicle Sales Meeting Zero Emission Vehicle Requirements

Model year	True Zero Emission Vehicle Sales Requirements	Total % of Zero Emission Vehicle Equivalents Sold Per Year
2018	1%	3%
2019	2%	4%
2020	3%	5%
2021	4%	6%
2022	4%	7%
2023	5%	8%
2024	6%	9%
2025	6%	10%

To reflect the proposed regulatory scenario, staff assessed the population fraction by technology group and vehicle class that would be sold in each calendar year, by process (exhaust and evaporative emissions), as a result of the proposed regulation.

Table 2-21, Table 2-22 Table 2-23, Table 2-24, Table 2-25, and Table 2-26 provide for the proposed regulatory scenario population splits by technology group for each regulated vehicle class.

Table 2-21. Population Technology Splits for the Proposed Regulatory Scenario: Passenger Cars

Regulatory Scenario Technology Fractions for Passenger Cars (PC or LDA)															
Calendar Year	Ev011	Ev015	Ev016	Ev017	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex043	Ex044	Ex178	Ex179	Ex180
	Evaporative				Exhaust										
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010	0.005	0.784	0.001	0.210	0.001	0.050	0.738	0.210			0.001		0.250	0.750	
2011	0.019	0.771	0.001	0.210	0.001	0.050	0.738	0.210			0.001		0.250	0.750	
2012	0.011	0.777	0.002	0.210	0.010	0.050	0.732	0.207			0.001		0.250	0.750	
2013	0.013	0.775	0.002	0.210	0.010	0.050	0.730	0.209			0.001		0.250	0.750	
2014		0.788	0.002	0.210	0.010	0.050	0.729	0.210			0.001		0.250	0.750	
2015		0.781	0.009	0.210	0.019	0.050	0.632	0.217			0.001	0.081	0.250	0.750	
2016		0.780	0.010	0.210	0.021	0.030	0.504	0.217			0.001	0.228	0.250	0.750	
2017		0.780	0.010	0.210	0.021	0.030	0.378	0.217			0.001	0.354	0.250	0.750	
2018		0.399	0.016	0.585	0.039		0.250	0.244			0.001	0.466	0.250	0.750	
2019		0.400	0.032	0.568	0.060		0.137	0.251			0.001	0.551	0.250	0.750	
2020		0.201	0.047	0.752	0.079		0.020	0.257	0.050		0.001	0.592	0.250	0.750	
2021		0.200	0.061	0.739	0.097			0.265	0.050	0.282	0.001	0.305			1.000
2022			0.072	0.928	0.114			0.272	0.100	0.453	0.001	0.060			1.000
2023			0.084	0.916	0.130			0.402	0.100	0.317	0.001	0.050			1.000
2024			0.094	0.906	0.144			0.404	0.275	0.150	0.001	0.026			1.000
2025			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2026			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2027			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2028			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2029			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2030			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2031			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2032			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2033			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2034			0.102	0.898	0.157			0.560	0.282		0.001				1.000
2035			0.102	0.898	0.157			0.560	0.282		0.001				1.000

Table 2-22. Population Technology Splits for the Proposed Regulatory Scenario: Light Truck 1

Regulatory Scenario Technology Fraction for Light Duty Trucks (LDT1)											
Calendar Year	Ev035	Ev036	Ev037	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex044	Ex178
	Evaporative			Exhaust							
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel
2010	0.790		0.210		0.050	0.740	0.210				1.000
2011	0.790		0.210		0.050	0.740	0.210				1.000
2012	0.790		0.210		0.050	0.740	0.210				1.000
2013	0.790		0.210		0.050	0.740	0.210				1.000
2014	0.790		0.210		0.050	0.740	0.210				1.000
2015	0.790		0.210		0.030	0.691	0.210			0.069	1.000
2016	0.790		0.210		0.030	0.520	0.210			0.240	1.000
2017	0.790		0.210		0.000	0.440	0.210			0.350	1.000
2018	0.400		0.600		0.000	0.316	0.210			0.474	1.000
2019	0.400		0.600			0.197	0.210			0.593	1.000
2020	0.200		0.800			0.057	0.210	0.050		0.683	1.000
2021	0.200		0.800				0.210	0.050	0.190	0.550	1.000
2022			1.000				0.210	0.100	0.576	0.114	1.000
2023			1.000				0.389	0.100	0.511		1.000
2024			1.000				0.466	0.200	0.334		1.000
2025			1.000				0.800	0.200			1.000
2026			1.000				0.800	0.200			1.000
2027			1.000				0.800	0.200			1.000
2028			1.000				0.800	0.200			1.000
2029			1.000				0.800	0.200			1.000
2030			1.000				0.800	0.200			1.000
2031			1.000				0.800	0.200			1.000
2032			1.000				0.800	0.200			1.000
2033			1.000				0.800	0.200			1.000
2034			1.000				0.800	0.200			1.000
2035			1.000				0.800	0.200			1.000

Table 2-23. Population Technology Splits for the Proposed Regulatory Scenario: Light Truck 2

Regulatory Scenario Technology Fraction for Light Duty Trucks (LDT2)											
Calendar Year	Ev035	Ev036	Ev037	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex044	Ex178
	Evaporative			Exhaust							
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel
2010	1.000				0.040	0.960					1.000
2011	1.000				0.040	0.960					1.000
2012	1.000				0.040	0.960					1.000
2013	1.000				0.040	0.960					1.000
2014	1.000				0.040	0.960					1.000
2015	1.000				0.050	0.812				0.138	1.000
2016	1.000				0.050	0.760				0.190	1.000
2017	1.000				0.050	0.529				0.421	1.000
2018	0.400		0.600		0.050	0.528				0.422	1.000
2019	0.400		0.600		0.050	0.423				0.527	1.000
2020	0.200		0.800		0.050	0.364				0.586	1.000
2021	0.200		0.800		0.040	0.241				0.719	1.000
2022			1.000		0.040	0.237			0.273	0.450	1.000
2023			1.000		0.040	0.050	0.160		0.300	0.450	1.000
2024			1.000		0.030		0.266		0.500	0.204	1.000
2025			1.000		0.020		0.724		0.256		1.000
2026			1.000		0.020		0.724		0.256		1.000
2027			1.000		0.020		0.724		0.256		1.000
2028			1.000		0.020		0.724		0.256		1.000
2029			1.000		0.020		0.724		0.256		1.000
2030			1.000		0.020		0.724		0.256		1.000
2031			1.000		0.020		0.724		0.256		1.000
2032			1.000		0.020		0.724		0.256		1.000
2033			1.000		0.020		0.724		0.256		1.000
2034			1.000		0.020		0.724		0.256		1.000
2035			1.000		0.020		0.724		0.256		1.000

Table 2-24. Population Technology Splits for the Proposed Regulatory Scenario: Medium Duty Vehicles

Regulatory Scenario Technology Fractions for Medium Duty Vehicles (MDV)												
Calendar Year	**Ev035**	**Ev036**	**Ev038**	**Ex025**	**Ex028**	**Ex029**	**Ex031**	**Ex039**	**Ex044**	**Ex178**	**Ex179**	**Ex180**
	Evaporative			**Exhaust**								
	Gasoline	**Gasoline**	**Gasoline**	**Gasoline**	**Gasoline**	**Gasoline**	**Gasoline**	**Gasoline**	**Gasoline**	**Diesel**	**Diesel**	**Diesel**
2010	1.000				0.150	0.850				0.250	0.750	
2011	1.000				0.150	0.850				0.250	0.750	
2012	1.000				0.150	0.850				0.250	0.750	
2013	1.000				0.150	0.850				0.250	0.750	
2014	1.000				0.150	0.850				0.250	0.750	
2015	1.000				0.051	0.810			0.138	0.250	0.750	
2016	1.000				0.051	0.758			0.191	0.250	0.750	
2017	1.000				0.051	0.528			0.421	0.250	0.750	
2018	0.400		0.600		0.051	0.527			0.422	0.250	0.750	
2019	0.400		0.600		0.051	0.423			0.526	0.250	0.750	
2020	0.200		0.800		0.051	0.364			0.584	0.250	0.750	
2021	0.200		0.800		0.040	0.241			0.719			1.000
2022			1.000		0.040	0.237		0.273	0.450			1.000
2023			1.000		0.040	0.050	0.160	0.300	0.450			1.000
2024			1.000		0.030		0.266	0.500	0.204			1.000
2025			1.000		0.020		0.724	0.256				1.000
2026			1.000		0.020		0.724	0.256				1.000
2027			1.000		0.020		0.724	0.256				1.000
2028			1.000		0.020		0.724	0.256				1.000
2029			1.000		0.020		0.724	0.256				1.000
2030			1.000		0.020		0.724	0.256				1.000
2031			1.000		0.020		0.724	0.256				1.000
2032			1.000		0.020		0.724	0.256				1.000
2033			1.000		0.020		0.724	0.256				1.000
2034			1.000		0.020		0.724	0.256				1.000
2035			1.000		0.020		0.724	0.256				1.000

Table 2-25. Population Technology Splits for the Proposed Regulatory Scenario: Light-Heavy Truck 1

Regulatory Scenario Technology Fraction for Light Heavy Duty Trucks (LHD1)						
Calendar Year	Ex054	Ex058	Ex059	Ex071	Ex073	Ex074
	Exhaust					
	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010	1.000			1.000		
2011	1.000			1.000		
2012	1.000			1.000		
2013	1.000			1.000		
2014	1.000			1.000		
2015	1.000			1.000		
2016	0.800	0.200		0.801	0.199	0.000
2017	0.599	0.401		0.602	0.398	0.000
2018	0.401	0.500	0.099	0.398	0.500	0.102
2019	0.300	0.401	0.299	0.300	0.401	0.300
2020	0.200	0.301	0.499	0.199	0.301	0.500
2021	0.099	0.200	0.700	0.102	0.199	0.699
2022		0.100	0.900		0.101	0.899
2023		0.100	0.900		0.101	0.899
2024		0.100	0.900		0.101	0.899
2025		0.100	0.900		0.101	0.899
2026		0.100	0.900		0.101	0.899
2027		0.100	0.900		0.101	0.899
2028		0.100	0.900		0.101	0.899
2029		0.100	0.900		0.101	0.899
2030		0.100	0.900		0.101	0.899
2031		0.100	0.900		0.101	0.899
2032		0.100	0.900		0.101	0.899
2033		0.100	0.900		0.101	0.899
2034		0.100	0.900		0.101	0.899
2035		0.100	0.900		0.101	0.899

Table 2-26. Population Technology Splits for the Proposed Regulatory Scenario: Light-Heavy Truck 2

Regulatory Scenario Technology Fraction for Light Heavy Duty Trucks (LHD2)						
Calendar Year	Ex084	Ex086	Ex087	Ex101	Ex104	Ex105
	Exhaust					
	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010	1.000			1.000		
2011	1.000			1.000		
2012	1.000			1.000		
2013	1.000			1.000		
2014	1.000			1.000		
2015	1.000			1.000		
2016	0.801	0.199		0.801	0.199	
2017	0.599	0.401		0.602	0.398	
2018	0.399	0.500	0.101	0.399	0.500	0.101
2019	0.300	0.401	0.300	0.300	0.400	0.300
2020	0.201	0.302	0.497	0.199	0.302	0.498
2021	0.101	0.201	0.698	0.101	0.199	0.699
2022		0.101	0.899		0.101	0.899
2023		0.101	0.899		0.101	0.899
2024		0.101	0.899		0.101	0.899
2025		0.101	0.899		0.101	0.899
2026		0.100	0.900		0.101	0.899
2027		0.100	0.900		0.101	0.899
2028		0.100	0.900		0.101	0.899
2029		0.100	0.900		0.101	0.899
2030		0.100	0.900		0.101	0.899
2031		0.100	0.900		0.101	0.899
2032		0.100	0.900		0.101	0.899
2033		0.100	0.900		0.101	0.899
2034		0.100	0.900		0.101	0.899
2035		0.100	0.900		0.101	0.899

2.7.C Alternative Accelerated Criteria Pollutant Regulatory Scenario

Staff considered and rejected an alternative regulatory scenario that would have accelerated fleet average emissions standards by three years to 2022. To reflect the accelerated regulatory scenario, staff assessed the population fraction by technology group and vehicle class that would be sold in each calendar year, by process (exhaust and evaporative emissions). Table 2-27, Table 2-28, Table 2-29, Table 2-30, Table 2-31, and Table 2-32 provide, for the accelerated criteria pollutant regulatory scenarios, population splits by technology group for each regulated vehicle class.

Table 2-27. Accelerated Criteria Pollutant Regulatory Scenario Population Technology Splits: Passenger Cars.

Alternative Regulatory Scenario Technology Fractions for Passenger Cars (PC or LDA)															
Calendar Year	Ev011	Ev015	Ev016	Ev017	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex043	Ex044	Ex178	Ex179	Ex180
	Evaporative				Exhaust										
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010	0.005	0.784	0.001	0.210	0.001	0.050	0.738	0.210			0.001		0.250	0.750	
2011	0.019	0.771	0.001	0.210	0.001	0.050	0.738	0.210			0.001		0.250	0.750	
2012	0.011	0.777	0.002	0.210	0.010	0.050	0.730	0.210			0.001		0.250	0.750	
2013	0.013	0.775	0.002	0.210	0.010	0.050	0.729	0.210			0.001		0.250	0.750	
2014		0.788	0.002	0.210	0.010	0.050	0.729	0.210			0.001		0.250	0.750	
2015		0.781	0.009	0.210	0.019	0.050	0.586	0.218			0.001	0.125	0.250	0.750	
2016		0.780	0.010	0.210	0.021		0.488	0.217			0.001	0.274	0.250	0.750	
2017		0.780	0.010	0.210	0.021		0.303	0.217			0.001	0.459	0.250	0.750	
2018		0.399	0.016	0.585	0.039		0.154	0.244			0.001	0.562	0.250	0.750	
2019		0.400	0.032	0.568	0.060			0.251			0.001	0.688	0.250	0.750	
2020		0.201	0.047	0.752	0.079			0.261	0.050	0.279	0.001	0.329	0.250	0.750	
2021		0.200	0.061	0.739	0.097			0.402	0.050	0.449	0.001				1.000
2022			0.072	0.928	0.114			0.785	0.100		0.001				1.000
2023			0.084	0.916	0.130			0.769	0.100		0.001				1.000
2024			0.094	0.906	0.144			0.655	0.200		0.001				1.000
2025			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2026			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2027			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2028			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2029			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2030			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2031			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2032			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2033			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2034			0.102	0.898	0.157			0.642	0.200		0.001				1.000
2035			0.102	0.898	0.157			0.642	0.200		0.001				1.000

Table 2-28. Accelerated Criteria Pollutant Regulatory Scenario Population Technology Splits: Light Truck 1

Alternative Regulatory Scenario Technology Fractions for Light Duty Trucks (LDT1)											
Calendar Year	Ev035	Ev036	Ev037	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex044	Ex178
	Evaporative			Exhaust							
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel
2010	0.790		0.210		0.050	0.740	0.210				1.000
2011	0.790		0.210		0.050	0.740	0.210				0.000
2012	0.790		0.210		0.050	0.740	0.210				0.000
2013	0.790		0.210		0.050	0.740	0.210				0.000
2014	0.790		0.210		0.050	0.740	0.210				0.000
2015	0.790		0.210		0.050	0.570	0.210			0.170	0.000
2016	0.790		0.210			0.470	0.210			0.320	
2017	0.790		0.210			0.275	0.210			0.515	
2018	0.400		0.600			0.100	0.210			0.690	
2019	0.400		0.600				0.210		0.240	0.550	
2020	0.200		0.800				0.210	0.010	0.730	0.050	
2021	0.200		0.800				0.640	0.010	0.350		
2022			1.000				0.950	0.050			
2023			1.000				0.950	0.050			
2024			1.000				0.900	0.100			
2025			1.000				0.800	0.200			
2026			1.000				0.800	0.200			
2027			1.000				0.800	0.200			
2028			1.000				0.800	0.200			
2029			1.000				0.800	0.200			
2030			1.000				0.800	0.200			
2031			1.000				0.800	0.200			
2032			1.000				0.800	0.200			
2033			1.000				0.800	0.200			
2034			1.000				0.800	0.200			
2035			1.000				0.800	0.200			

Table 2-29. Accelerated Criteria Pollutant Regulatory Scenario Population Technology Splits: Light Truck 2

Alternative Regulatory Scenario Technology Fractions for Light Duty Trucks (LDT2)											
Calendar Year	Ev035	Ev036	Ev037	Ex025	Ex028	Ex029	Ex031	Ex038	Ex039	Ex044	Ex178
	Evaporative			Exhaust							
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel
2010	1.000				0.040	0.960					1.000
2011	1.000				0.040	0.960					0.000
2012	1.000				0.040	0.960					0.000
2013	1.000				0.040	0.960					0.000
2014	1.000				0.040	0.960					0.000
2015	1.000				0.050	0.761				0.189	0.000
2016	1.000					0.612				0.388	0.000
2017	1.000					0.393				0.607	0.000
2018	0.400		0.600			0.181				0.819	0.000
2019	0.400		0.600						0.100	0.900	0.000
2020	0.200		0.800						0.680	0.320	0.000
2021	0.200		0.800				0.390		0.540	0.070	
2022			1.000				0.800		0.200		
2023			1.000				0.800		0.200		
2024			1.000				0.800		0.200		
2025			1.000				0.800		0.200		
2026			1.000				0.800		0.200		
2027			1.000				0.800		0.200		
2028			1.000				0.800		0.200		
2029			1.000				0.800		0.200		
2030			1.000				0.800		0.200		
2031			1.000				0.800		0.200		
2032			1.000				0.800		0.200		
2033			1.000				0.800		0.200		
2034			1.000				0.800		0.200		
2035			1.000				0.800		0.200		

Table 2-30. Accelerated Criteria Pollutant Regulatory Scenario Population Technology Splits: Medium Duty Vehicles

Alternative Regulatory Scenario Technology Fractions for Medium Duty Vehicles (MDV)											
Calendar Year	Ev036	Ev038	Ex025	Ex028	Ex029	Ex031	Ex039	Ex044	Ex178	Ex179	Ex180
	Evaporative		Exhaust								
	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010				0.150	0.850				0.250	0.750	
2011				0.150	0.850				0.250	0.750	
2012				0.150	0.850				0.250	0.750	
2013				0.150	0.850				0.250	0.750	
2014				0.150	0.850				0.250	0.750	
2015				0.051	0.759			0.189	0.250	0.750	
2016					0.612			0.388	0.250	0.750	
2017					0.393			0.607	0.250	0.750	
2018		1.000			0.181			0.819	0.250	0.750	
2019		1.000					0.100	0.900	0.250	0.750	
2020		1.000					0.680	0.320	0.250	0.750	
2021		1.000				0.390	0.540	0.070			1.000
2022		1.000				0.800	0.200				1.000
2023		1.000				0.800	0.200				1.000
2024		1.000				0.700	0.300				1.000
2025		1.000				0.744	0.256				1.000
2026		1.000				0.744	0.256				1.000
2027		1.000				0.744	0.256				1.000
2028		1.000				0.744	0.256				1.000
2029		1.000				0.744	0.256				1.000
2030		1.000				0.744	0.256				1.000
2031		1.000				0.744	0.256				1.000
2032		1.000				0.744	0.256				1.000
2033		1.000				0.744	0.256				1.000
2034		1.000				0.744	0.256				1.000
2035		1.000				0.744	0.256				1.000

Table 2-31. Accelerated Criteria Pollutant Regulatory Scenario Population Technology Splits: Light-Heavy Truck

Alternative Regulatory Scenario Technology Fractions for Light Heavy Duty Trucks (LHD1)						
Calendar Year	Ex054	Ex058	Ex059	Ex071	Ex073	Ex074
	Exhaust					
	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010	1.000			1.000		
2011	1.000			1.000		
2012	1.000			1.000		
2013	1.000			1.000		
2014	1.000			1.000		
2015	1.000			1.000		
2016	0.800	0.200		0.801	0.199	
2017	0.599	0.401		0.602	0.398	
2018	0.401	0.500	0.099	0.398	0.500	0.102
2019	0.300	0.401	0.299	0.300	0.401	0.300
2020	0.200	0.301	0.499	0.199	0.301	0.500
2021	0.099	0.200	0.700	0.102	0.199	0.699
2022		0.100	0.900		0.101	0.899
2023		0.100	0.900		0.101	0.899
2024		0.100	0.900		0.101	0.899
2025		0.100	0.900		0.101	0.899
2026		0.100	0.900		0.101	0.899
2027		0.100	0.900		0.101	0.899
2028		0.100	0.900		0.101	0.899
2029		0.100	0.900		0.101	0.899
2030		0.100	0.900		0.101	0.899
2031		0.100	0.900		0.101	0.899
2032		0.100	0.900		0.101	0.899
2033		0.100	0.900		0.101	0.899
2034		0.100	0.900		0.101	0.899
2035		0.100	0.900		0.101	0.899

Table 2-32. Accelerated Criteria Pollutant Regulatory Scenario Population Technology Splits: Light-Heavy Truck 2

Alternative Regulatory Scenario Technology Fractions for Light Heavy Duty Trucks (LHD2)						
Calendar Year	Ex084	Ex086	Ex087	Ex101	Ex104	Ex105
	Exhaust					
	Gasoline	Gasoline	Gasoline	Diesel	Diesel	Diesel
2010	1.000			1.000		
2011	1.000			1.000		
2012	1.000			1.000		
2013	1.000			1.000		
2014	1.000			1.000		
2015	1.000			1.000		
2016	0.801	0.199		0.801	0.199	
2017	0.599	0.401		0.602	0.398	
2018	0.399	0.500	0.101	0.399	0.500	0.101
2019	0.300	0.401	0.300	0.300	0.400	0.300
2020	0.201	0.302	0.497	0.199	0.302	0.498
2021	0.101	0.201	0.698	0.101	0.199	0.699
2022		0.101	0.899		0.101	0.899
2023		0.101	0.899		0.101	0.899
2024		0.101	0.899		0.101	0.899
2025		0.101	0.899		0.101	0.899
2026		0.100	0.900		0.101	0.899
2027		0.100	0.900		0.101	0.899
2028		0.100	0.900		0.101	0.899
2029		0.100	0.900		0.101	0.899
2030		0.100	0.900		0.101	0.899
2031		0.100	0.900		0.101	0.899
2032		0.100	0.900		0.101	0.899
2033		0.100	0.900		0.101	0.899
2034		0.100	0.900		0.101	0.899
2035		0.100	0.900		0.101	0.899

2.8 Greenhouse Gas Regulatory Scenarios

The proposed ACC regulation includes new future year GHG emissions standards that reduce emissions as cleaner vehicles penetrate into the fleet. Because the standard is a fleet mix standard by calendar year, fleets have the option to comply with the standard in different ways, and the penetration of ZEV vehicles is one of many ways in which the standard may be met. As a result staff is modeling GHG benefits of the combined ACC program and is not evaluating the tailpipe emissions benefits of the ZEV program apart from other ACC requirements. In this section the proposed regulatory scenario is discussed. In addition, two other alternative scenarios, including a more aggressive and a less aggressive option, were considered and rejected are discussed here.

2.8.A Proposed Greenhouse Gas Regulatory Scenario

CO_2 reductions are projected as a result of the new vehicle standards that apply to cars and light trucks less than 8,500 pounds gross vehicle rated weight. Between 2016 and 2025 emission factors are reduced by roughly 4.5 percent per year. These CO_2 emission reduction estimations are approximate because the required emission level to achieve compliance with the standards for each vehicle manufacturing company depends on their ultimate sales mix of vehicles. Using the proposed phase-in schedule for the regulation discussed in Chapter 3, ARB staff estimated the percent reduction in CO_2 emissions rates by model year for those vehicles subject to the proposed regulation.[4] The percent reductions in CO2 by model year and vehicle class is shown in Table 2-33.

Table 2-33. Proposed GHG Standard for New Vehicles in California

	Category	Cars[5] (g/mi)	Trucks[6] (g/mi)	Average (g/mi)	Car Reductions	Truck Reductions
Base Year	2008	291	396	336	--	--
Proposed New Targets	2017	213	290	243	26.8%	26.8%
	2018	203	280	233	30.2%	29.3%
	2019	192	273	224	34.0%	31.1%
	2020	183	264	215	37.1%	33.3%
	2021	173	245	201	40.5%	38.1%
	2022	165	233	192	43.3%	41.2%
	2023	158	221	183	45.7%	44.2%
	2024	151	210	174	48.1%	47.0%
	2025	144	200	166	50.5%	49.5%

2.8.B Less Stringent Alternative Regulatory Scenario

Under this alternative, emissions would be reduced by 3 percent per year between 2016 and 2025. Using the proposed phase-in schedule for the regulation discussed in

[4] ARB staff has estimated the percent reduction in CO_2 emission rates using model year 2016 vehicles as a baseline.
[5] Passenger Cars (All)
[6] Trucks 0-8500 lb. Loaded Vehicle Weight

Chapter 3, ARB staff estimated the percent reduction in CO_2 emissions rates by model year for those vehicles subject to the proposed regulation.[7]

Table 2-34 shows the percentage reductions in CO2 by model year and vehicle class.

Table 2-34. Less Stringent Alternative GHG Standard for New Vehicles in California

	Category	Cars[8] (g/mile)	Trucks[9] (g/mile)	Average (g/mile)	Car Reductions	Truck Reductions
Base year	2008	291	396	336	--	--
Proposed New Targets	2017	219	284	244	24.7%	28.3%
	2018	212	275	237	27.1%	30.6%
	2019	206	267	230	29.2%	32.6%
	2020	199	259	223	31.6%	34.6%
	2021	193	251	216	33.7%	36.6%
	2022	188	243	210	35.4%	38.6%
	2023	182	236	203	37.5%	40.4%
	2024	176	229	197	39.5%	42.2%
	2025	171	222	191	41.2%	43.9%

2.8.C More Stringent Alternative Regulatory Scenario

Under this alternative, emissions would be reduced by 3 percent per year between 2016 and 2025. Using the proposed phase-in schedule for the regulation discussed in Chapter 3, ARB staff estimated the percent reduction in CO_2 emissions rates by model year for those vehicles subject to the proposed regulation.[10] Table 2-35 shows the percentage reductions in CO2 by model year and vehicle class.

Table 2-35. More Stringent Alternative GHG Standard for New Vehicles in California

[7] ARB staff has estimated the percent reduction in CO_2 emission rates using model year 2016 vehicles as a baseline.
[8] Passenger Cars (All)
[9] Trucks 0-8500 lb. Loaded Vehicle Weight
[10] ARB staff has estimated the percent reduction in CO_2 emission rates using model year 2016 vehicles as a baseline.

	Category	Cars[11] (g/mile)	Trucks[12] (g/mile)	Average (g/mile)	Car Reductions	Truck Reductions
Base year	2008	291	396	336	--	--
Proposed New Targets	2017	212	275	236	27.1%	30.6%
	2018	199	258	222	31.6%	34.8%
	2019	187	243	209	35.7%	38.6%
	2020	176	228	196	39.5%	42.4%
	2021	165	214	185	43.3%	46.0%
	2022	155	201	174	46.7%	49.2%
	2023	146	189	163	49.8%	52.3%
	2024	137	178	153	52.9%	55.1%
	2025	129	167	144	55.7%	57.8%

2.9 CARBITS Emissions Scenario Tool

Part of the economic analyses being completed for this proposed rulemaking is an assessment of consumer choice on projected new vehicle sales. Under the proposed regulation, new cars and trucks would be more expensive to purchase, and cheaper to operate than without the regulation. To assess the impact of consumer choice on new vehicle sales and future year vehicle fleets, the CARBITS model is used. The CARBITS model is a consumer choice model based on discrete choice modeling theory and was developed by the Institute of Transportation Studies at the University of California, Davis. More information on this model is provided in Chapter 9 of this document.

Under the proposed regulatory scenario, staff estimates that more vehicles will be sold than if the proposed regulation were not adopted. As a result the fleet would become newer over time since overall fleet turnover would occur more quickly under the proposed regulation than under baseline conditions. An increase in fleet turnover leading to a younger overall vehicle fleet would reduce emissions.

To assess this impact on emissions, staff developed an emissions modeling tool that could be linked to CARBITS output. In this tool, results from each scenario (baseline, adjusted baseline, proposed regulatory scenario, and alternative regulatory scenarios) are disaggregated into emission factors and activity by vehicle class and age. CARBITS baseline and regulatory scenario output, in the form of vehicle populations by vehicle class and calendar year can be read into the model. These populations can be multiplied by activity to estimate VMT and emission factors to estimate emissions by

[11] Passenger Cars (All)
[12] Trucks 0-8500 lb. Loaded Vehicle Weight

calendar year, model year, and vehicle class. Results from the analyses using the CARBITS emissions scenario tool are discussed in Chapter 9.

2.10 Regional Scenario Tool

In the ACC mobile source emissions inventory database tool, emissions are calculated at a statewide level. However, emissions assessments are necessary for both calculating the regional criteria pollutant benefits of the proposed regulations, and for assessing regional emissions inventories for input to ambient particulate matter health effects assessments. To calculate regional inventories, staff used a separate database tool. The ACC regional scenario tool is built upon EMFAC2011-LDV output by geographical area (counties split by air basin boundaries), vehicle class, calendar year, and model year. A .bdn output from EMFAC2011-LDV was used to develop the base inventory. Two inventories were generated: a summer inventory for assessing criteria pollutant benefits, and an annual inventory for input to health effects calculations.

Staff then used the statewide ACC mobile source emissions inventory database tool to quantify percentage changes in VMT and emissions by calendar year, vehicle class, and model year, for each criteria pollutant scenario (adjusted baseline, proposed regulatory scenario, and accelerated regulatory scenario). The summer and annual regional inventories are then multiplied by the control factors to estimate regional emissions under each scenario.

3 Statewide Emissions Inventory Results

This section describes the results of the Statewide emissions inventory results developed using the ACC mobile source emissions inventory database tool.

3.1 Criteria Pollutants

3.1.A Adjusted Baseline

Adjusted baseline inventories are compared to EMFAC2011-LDV in Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4. ROG, NOx, and CO emissions show very little difference between EMFAC2011 and the adjusted baseline, largely because the changes in technology penetration affected the vehicle technology mix without affecting the overall fleet average emission rate. Adjusted PM2.5 emissions are higher than EMFAC2011 because newer LEV-II PFI engines are assumed to emit more PM2.5 based on more recent testing data than was assumed in EMFAC2011.

Figure 3-1. EMFAC2011-LDV and Adjusted Baseline Statewide Emissions: ROG

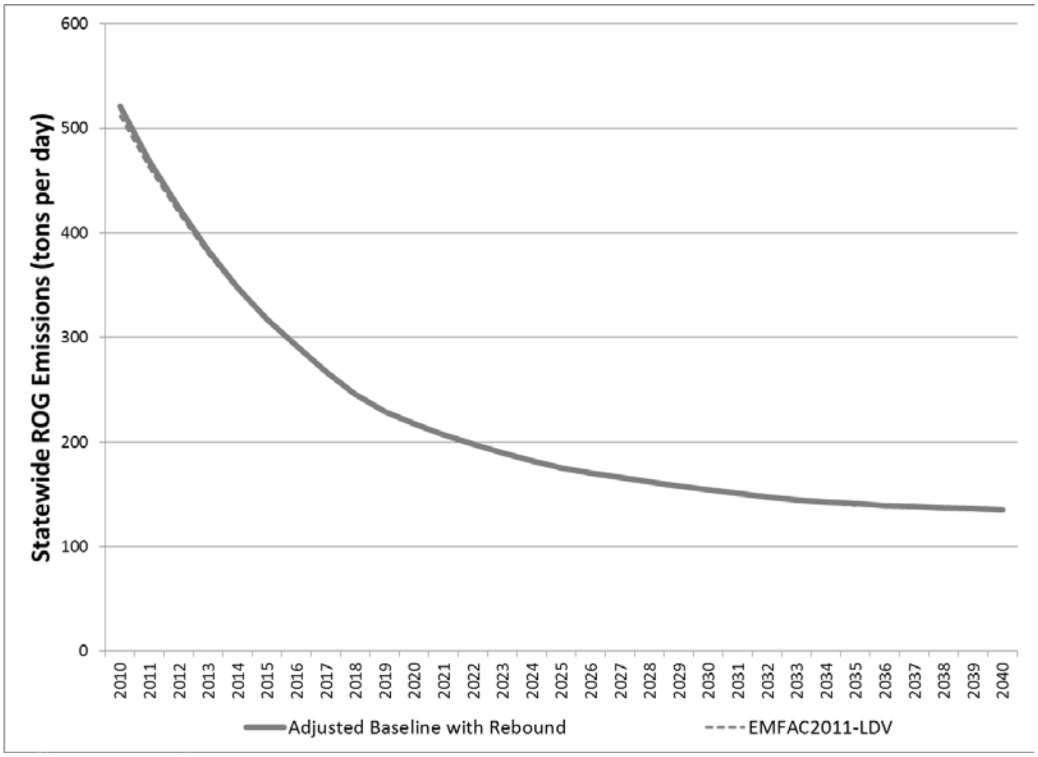


Figure 3-2. EMFAC2011-LDV and Adjusted Baseline Statewide Emissions: NOx

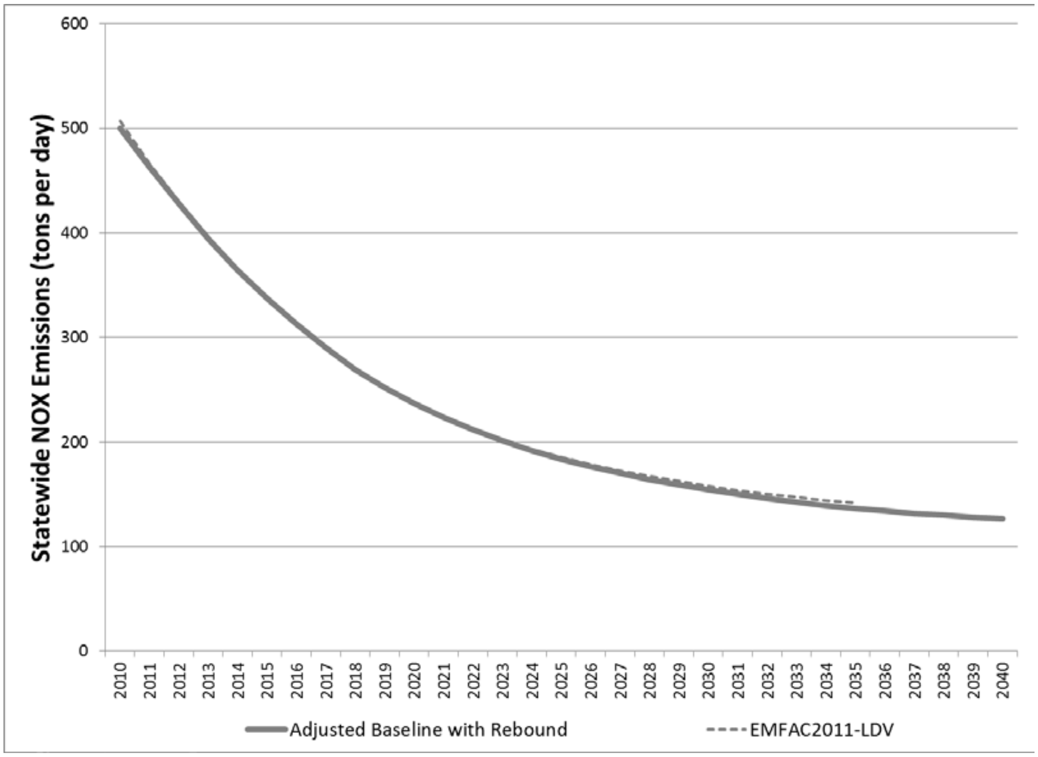


Figure 3-3. EMFAC2011-LDV and Adjusted Baseline Statewide Emissions: CO

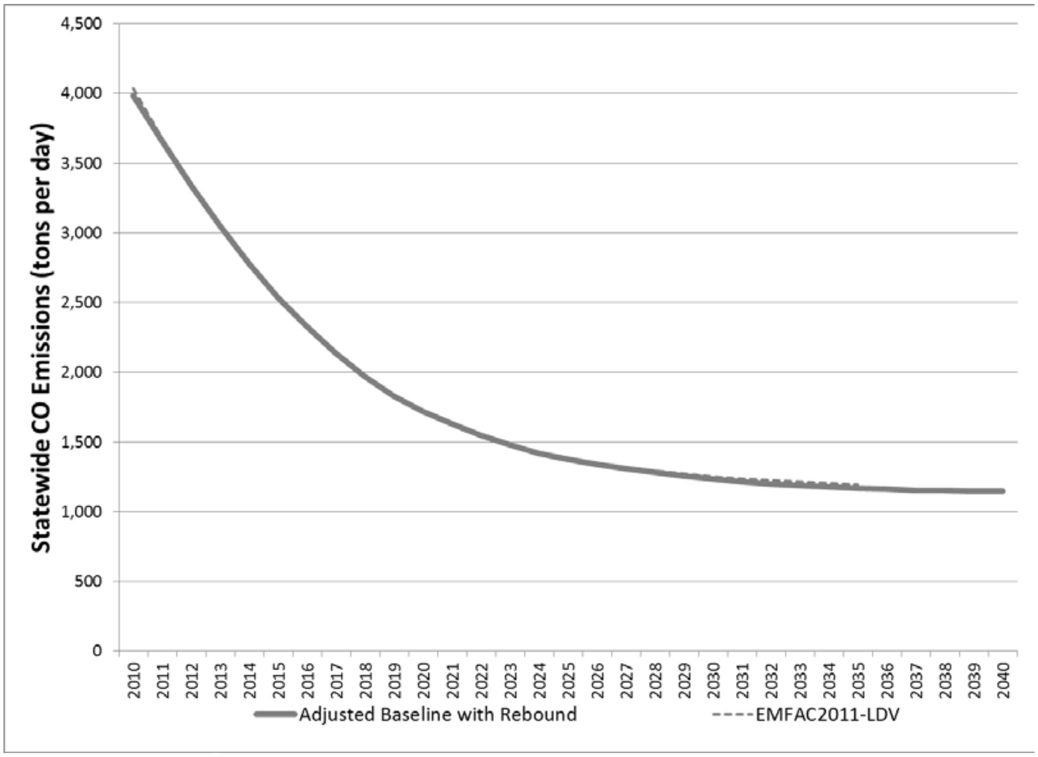
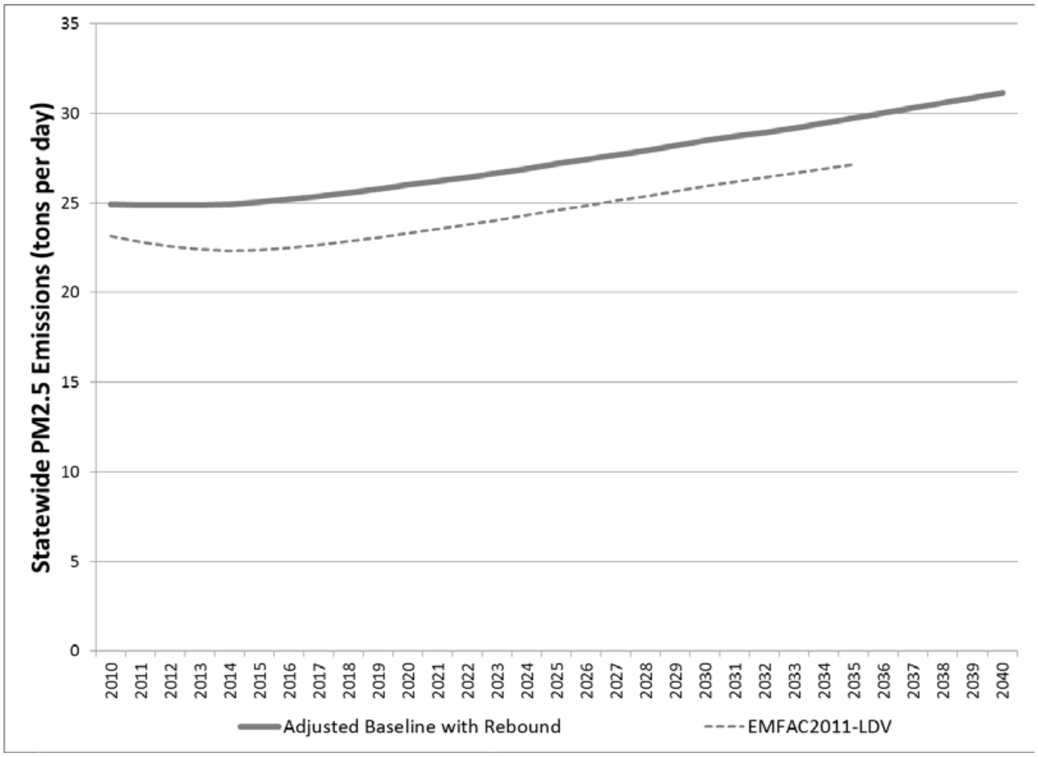


Figure 3-4. EMFAC2011-LDV and Adjusted Baseline Statewide Emissions: PM2.5



3.1.B Proposed Regulatory Scenario

Figure 3-5 and Figure 3-6 show the remaining emissions for ROG and NOx under baseline conditions and under the proposed regulations. Under currently adopted rules, ROG and NOx emissions are projected to decrease by 82 percent between 2010 and 2035. This reduction is caused by the penetration of LEV-II vehicles into the fleet. The penetration of LEV-III vehicles would begin reducing emissions in 2017; by 2040 ROG emissions would be reduced by 46 percent from the adjusted baseline, and NOx emissions by 47 percent. Figure 3-7 shows CO emissions benefits of the proposed regulation.

Figure 3-8 shows the estimated remaining emissions for PM2.5 under baseline conditions and under the proposed regulations. Under the adjusted baseline PM emissions are higher than previously estimated both today and in the future because all LEV-II compliant vehicles are assumed to emit PM at roughly 4 mg/mile from 1996 into the future and VMT is expected to increase as California's population grows. This level is well below the current LEV-II standard of 10 mg/mile. Under the proposed rule, the new standard is reduced to 3 mg/mile in 2020 and 1 mg/mile in 2028. With these standards PM2.5 emissions will be essentially unchanged between 2010 and 2040. It should be noted that these emission levels are very low. A typical car will drive roughly 150,000 miles over its lifetime. At that mileage and the 1 mg/mile emission rate, the car would emit a total of 150g or 1/3 of a pound of particulate matter over its entire lifetime.

Figure 3-5. ROG Emissions: Baseline vs Proposed Regulations

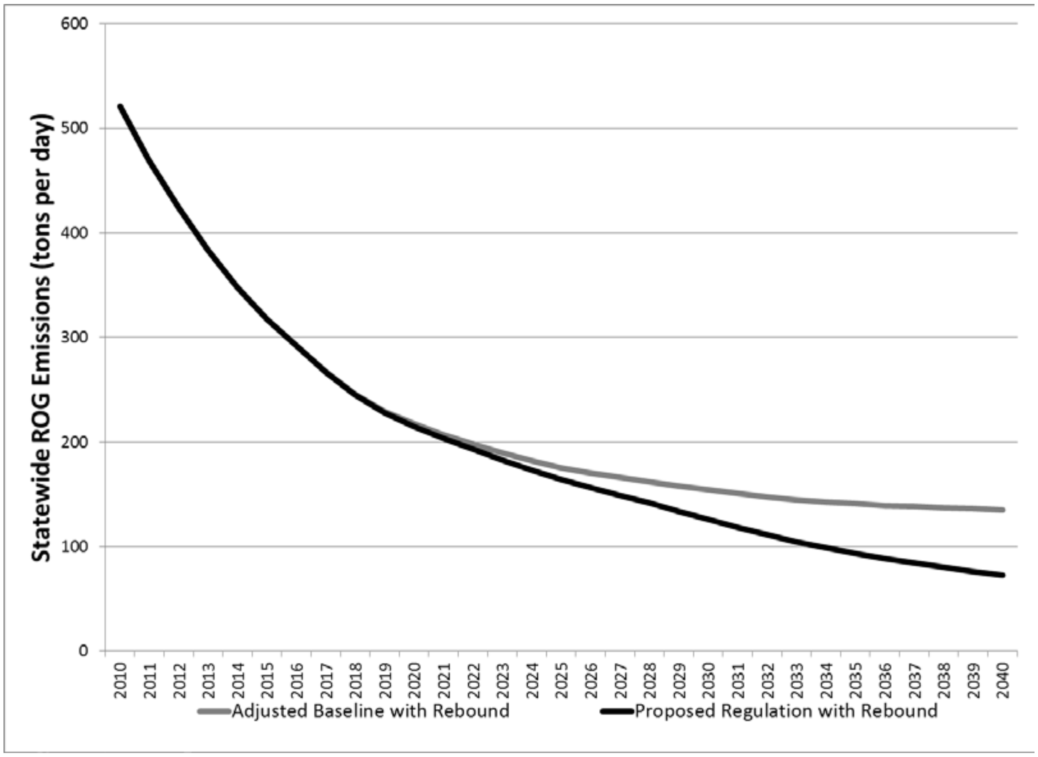


Figure 3-6. NOx Emissions: Baseline vs. Proposed Regulations

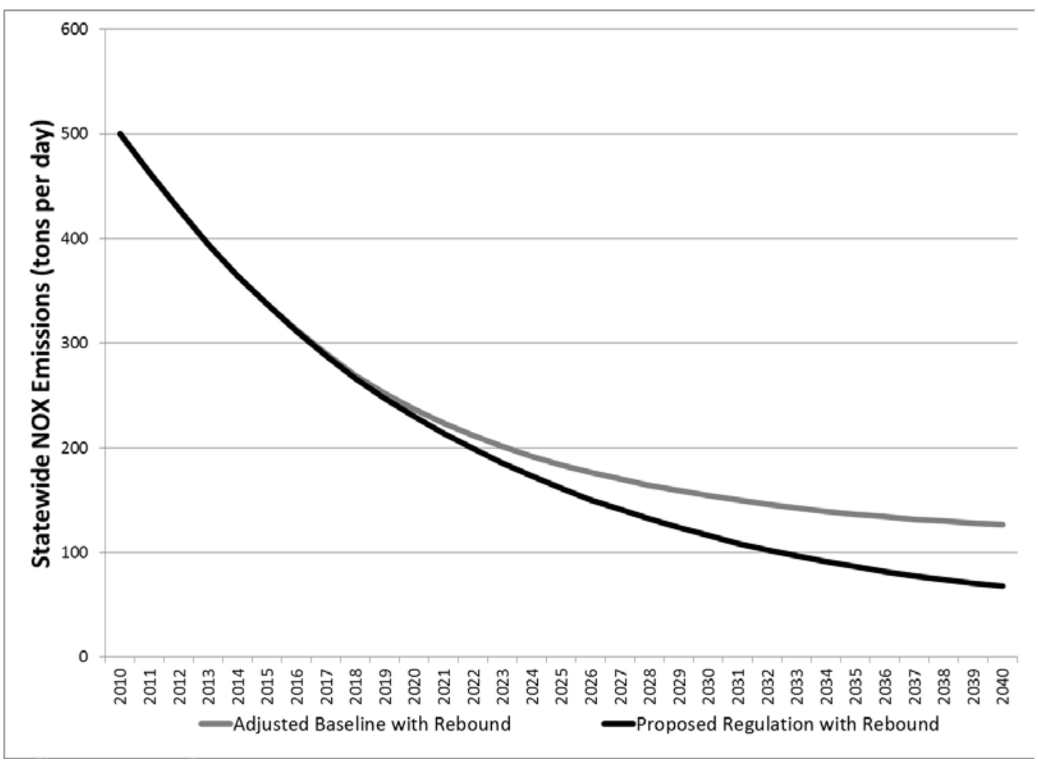


Figure 3-7. CO Emissions: Baseline vs Proposed Regulations

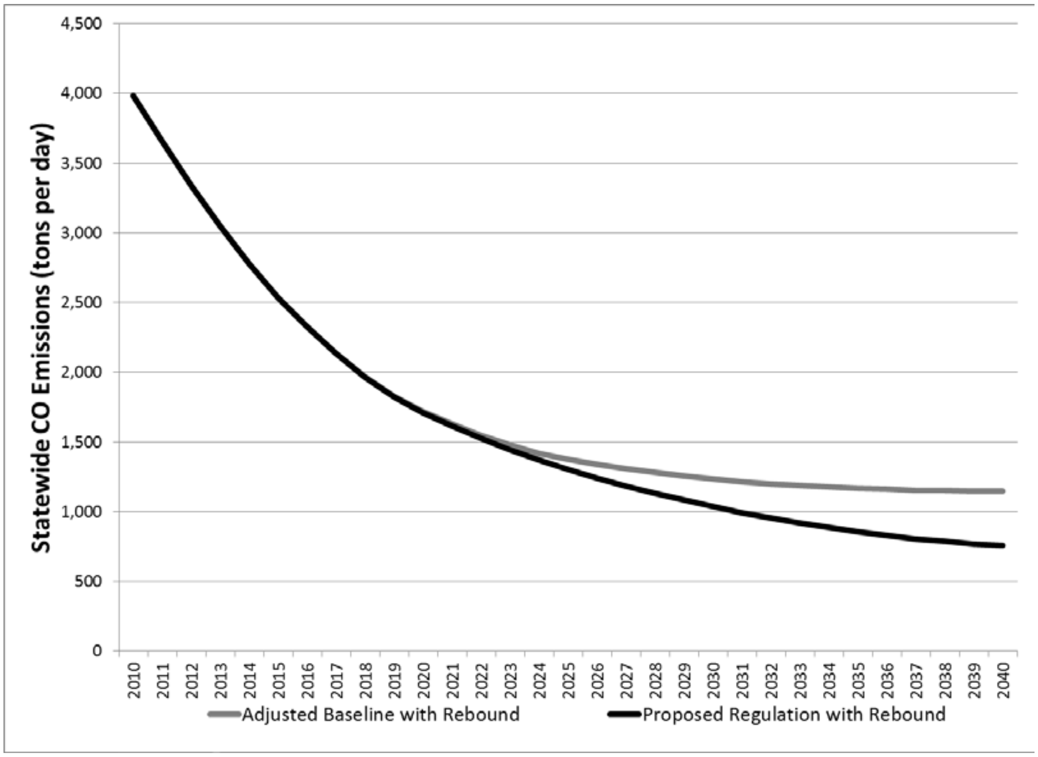
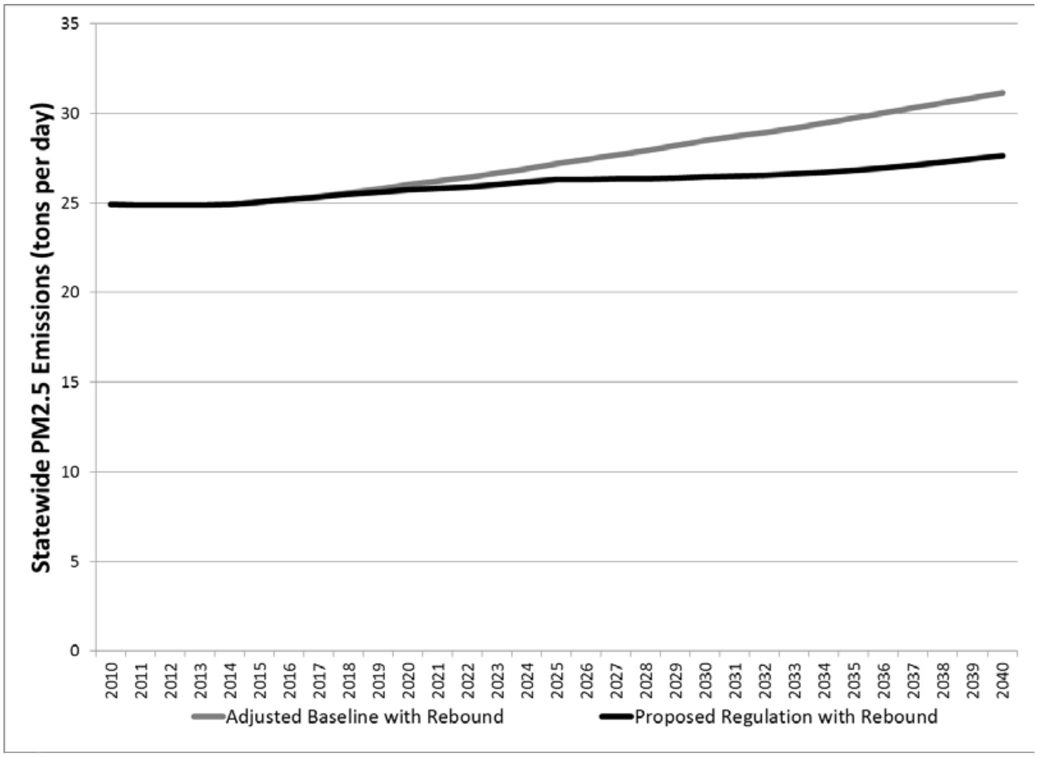


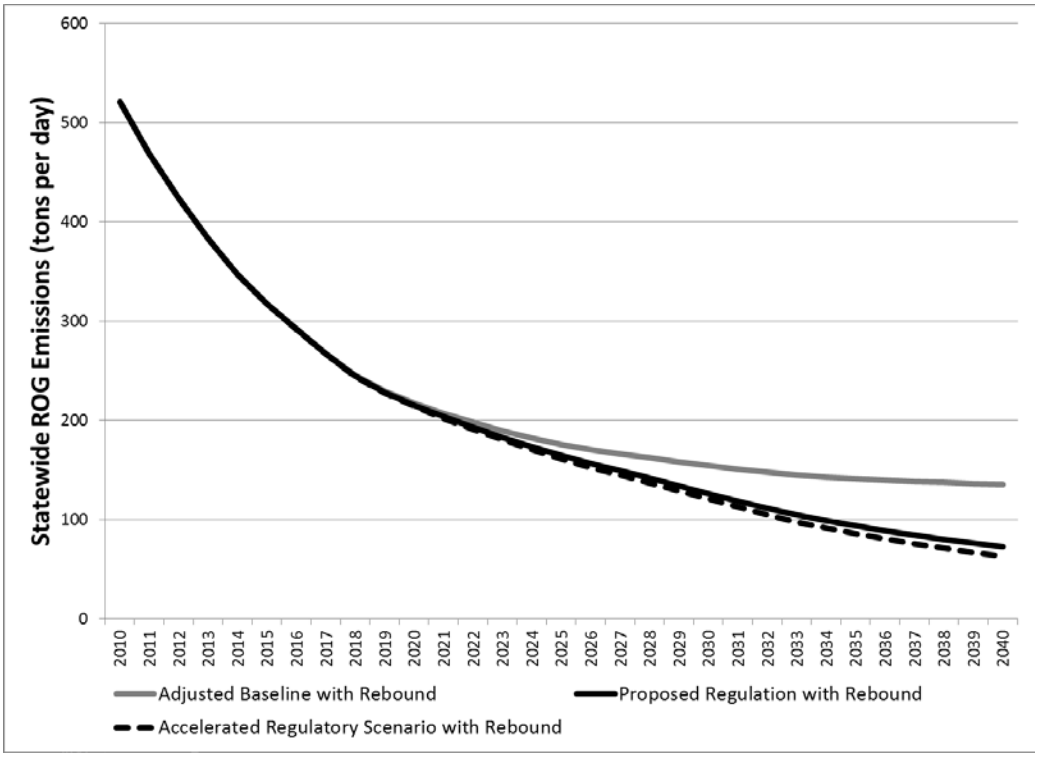
Figure 3-8. PM2.5 Emissions: Baseline vs Proposed Regulations



3.1.C Accelerated Regulatory Scenario

The accelerated regulatory scenario that was considered and rejected would provide very small additional emissions benefits relative to the proposed scenario, as shown in Figure 3-9, Figure 3-10, and Figure 3-11.

Figure 3-9. ROG Emissions: Baseline, Proposed, and Accelerated Scenarios



Statewide ROG Emissions (tons per day)
600
500
400
300
200
100
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
Adjusted Baseline with Rebound
Proposed Regulation with Rebound
Accelerated Regulatory Scenario with Rebound

Figure 3-10. NOx Emissions: Baseline, Proposed, and Accelerated Scenarios

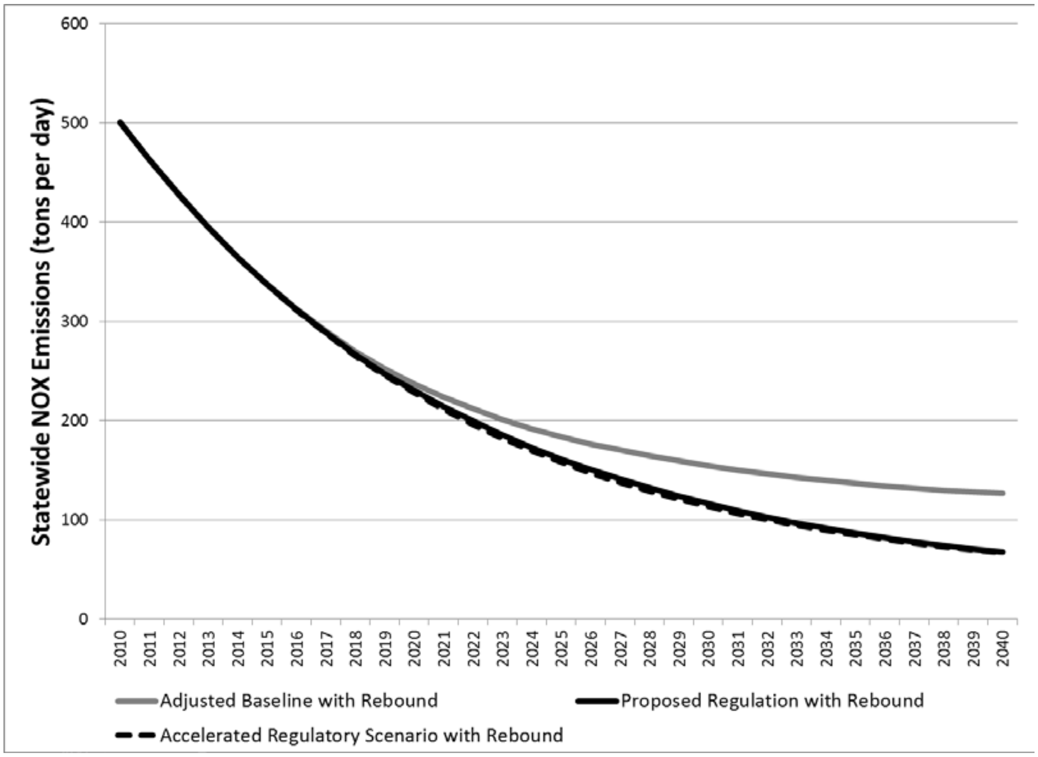
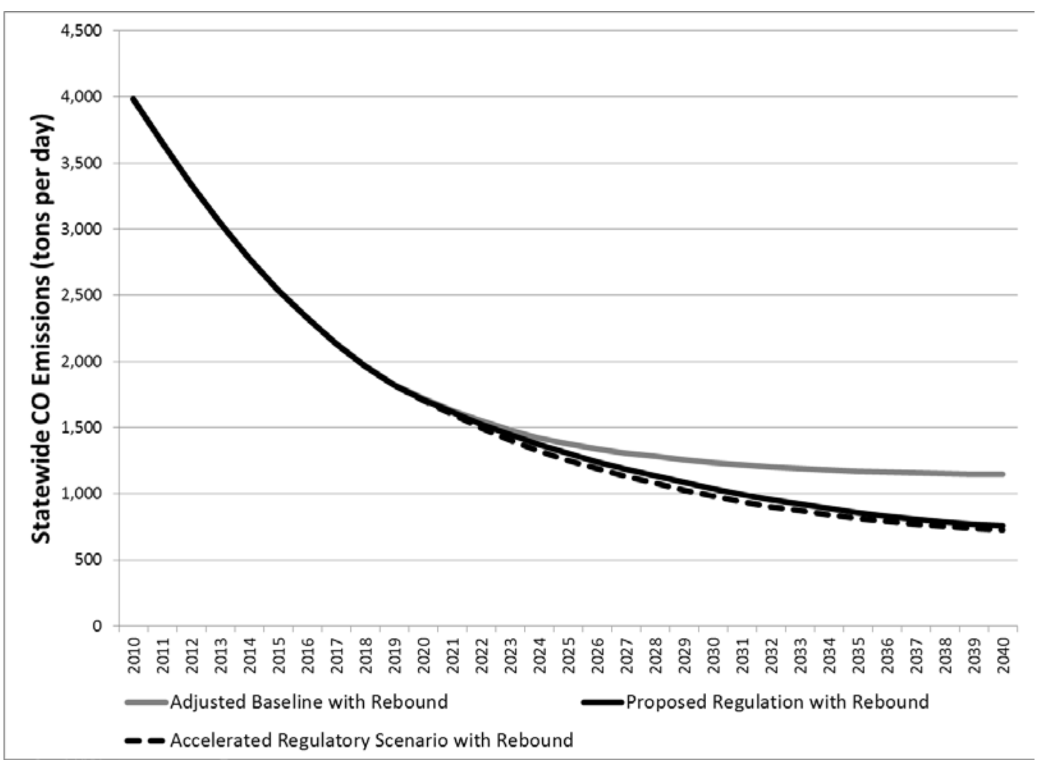


Figure 3-11. CO Emissions: Baseline, Proposed, and Accelerated Scenarios



3.2 Greenhouse Gas Emissions

3.2.A Adjusted Baseline

Figure 3-12 compares EMFAC2011-LDV and the adjusted baseline inventory for CO2 equivalent emissions before the rebound adjustment. The two main adjustments in the baseline inventory pertaining to CO2 are integration of the Pavley-I federal standard and the Low Carbon Fuel Standard. Recent amendments to the Pavley regulations provided the vehicle manufacturers the option to show compliance with the California Pavley standards by complying with the Federal standards. Based on certification data nearly all of the manufacturers have chosen to comply using the federal standards. For this reason the federal standards are reflected in the inventory analysis.

Figure 3-12 shows those two adopted regulations are anticipated to generate significant greenhouse gas benefits into the future. SB 375, which directed ARB to set regional greenhouse gas emission reduction targets for passenger vehicles, is expected to result in a 3% reduction of greenhouse gases in 2020 and 13% reduction in 2035 from the adjusted baseline. These benefits are discussed here but not included in this analysis or shown in the figure.

Figure 3-13 shows the impact of rebound on the calculation. The emissions impact of rebound is very small and does not materially impact emissions benefits that would be achieved through the proposed regulation.

Figure 3-12. Statewide CO2 Equivalent Emissions: EMFAC2011-LDV and Adjusted Baseline (No Rebound)

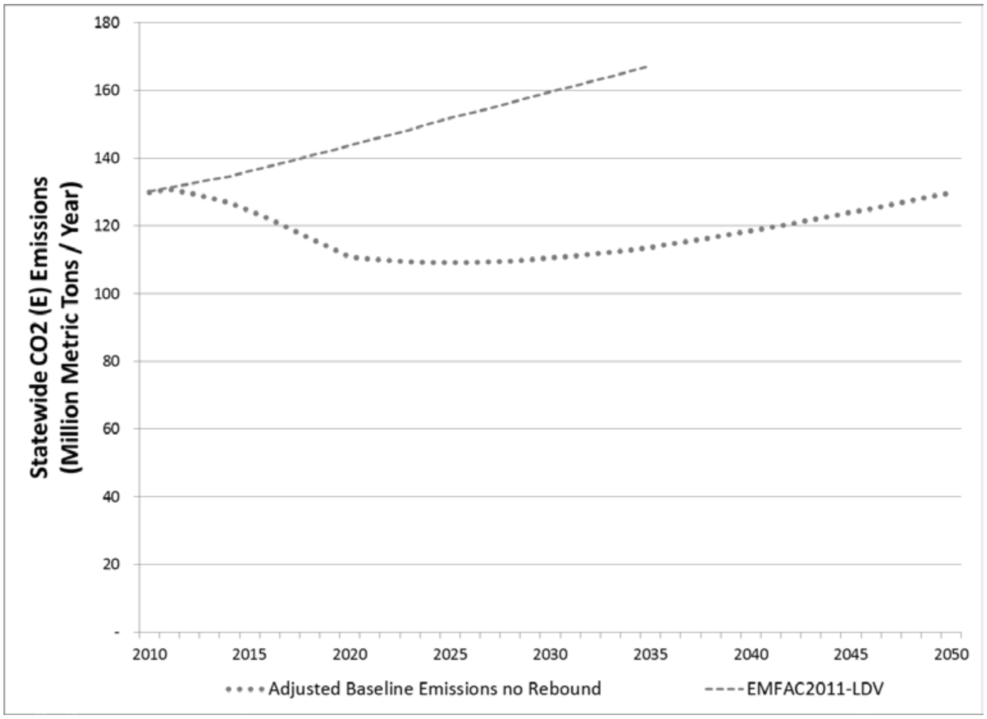
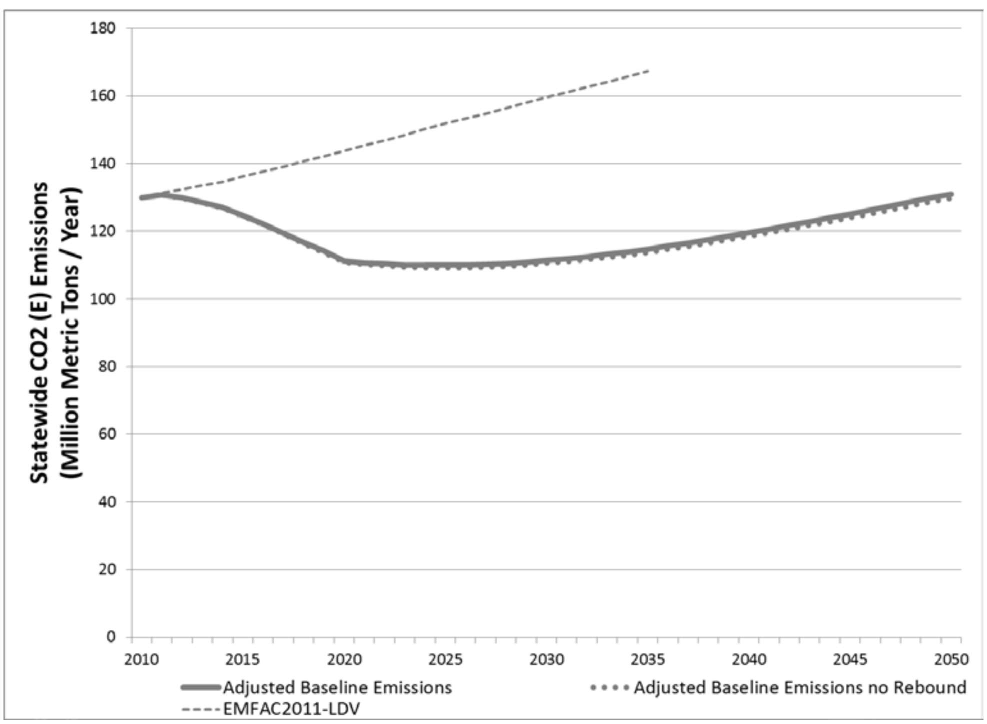


Figure 3-13. Statewide Statewide CO2 Equivalent Emissions: EMFAC2011-LDV and Adjusted Baseline (With Rebound)



3.2.B Proposed Regulatory Scenario

Figure 3-14 compares the adjusted baseline CO_2 equivalent emissions, which include benefits of the federal standard adopted through the Pavley-I regulation and the Low Carbon Fuel Standard, to estimated emissions under the proposed ACC regulation. Under the adjusted baseline emissions reach a peak in 2011, and begin a downward trajectory due to currently adopted regulations. This downward trajectory ends by 2030 when the fleet has turned over to Pavley-I compliant vehicles. After that point projected growth in vehicle miles traveled is expected to increase emissions. Under the proposed regulations emissions would decline as new ACC compliant vehicles enter the fleet. By 2040 the fleet is expected to have turned over to ACC compliant vehicles and after that point VMT growth increases emissions.

As shown in Figure 3-14, the benefits from the proposed ACC standard will be substantial. By 2025 CO_2 equivalent emissions would be reduced by almost 14 Million Metric Tons (MMT) per year, which is 12 percent from baseline levels. The reduction increases in 2035 to 32 MMT/Yr which is a 27 percent reduction from baseline levels. By 2050 the proposed regulation will reduce emissions by more than 42 MMT/Yr, which is a reduction of 33 percent from baseline levels. Viewed cumulatively over the life of the regulation (2017-2050), the proposed ACC regulation would reduce emissions by more than 870 Million Metric Tons CO_2 Equivalent. To put this in context, in 2008 the entire State of California emitted 478 MMT CO_2 Equivalent. So the cumulative reductions that would be achieved by the proposed ACC Rule over the life of the regulation correspond to a little bit less than two years of emissions at current Statewide emission rates from all sources.

3.2.C Alternative Regulatory Scenarios

Two alternative regulatory scenarios were considered: a more stringent alternative and a less stringent alternative. Figure 3-15 shows the proposed and alternative greenhouse gas regulatory scenarios.

Figure 3-14: Statewide CO2 Equivalent Emission Reductions from Advanced Clean Car Regulations (With Rebound)

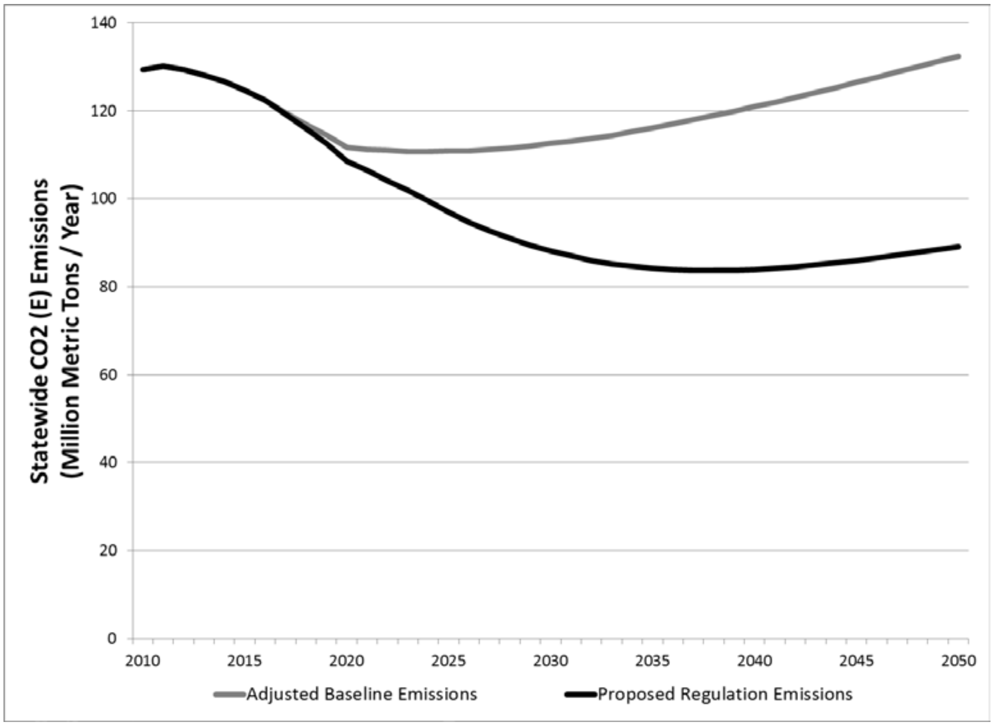
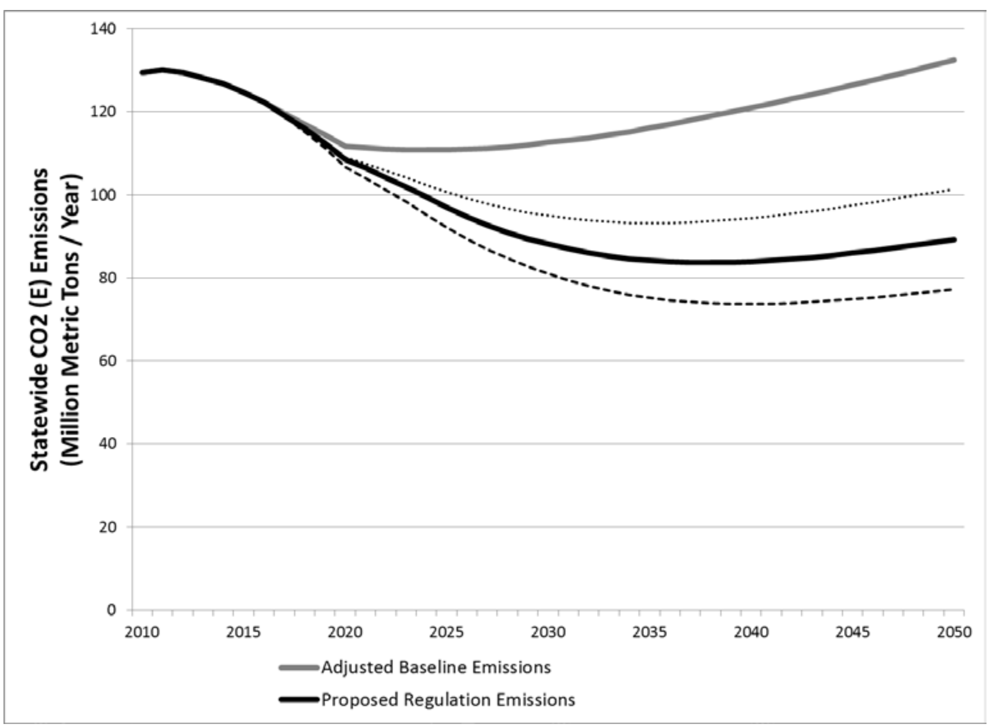


Figure 3-15. Statewide CO2 Equivalent Emissions Proposed vs Alternative Greenhouse Gas Regulatory Scenarios (with Rebound)



4 Regional Criteria Emissions Inventory Results

4.1 South Coast

Figure 4-1, Figure 4-2, Figure 4-3, and Figure 4-4 show ROG, NOx, PM2.5, and CO emissions in the Los Angeles region. Reductions in this region are similar in percentage to those seen statewide. 2023 is the currently required attainment date for the 1997 ozone standard in the Los Angeles region. The proposed regulation is estimated to provide a 6 ton per day NOx reduction in 2023.

Figure 4-1. South Coast ROG Emissions: Baseline vs. Proposed Regulations

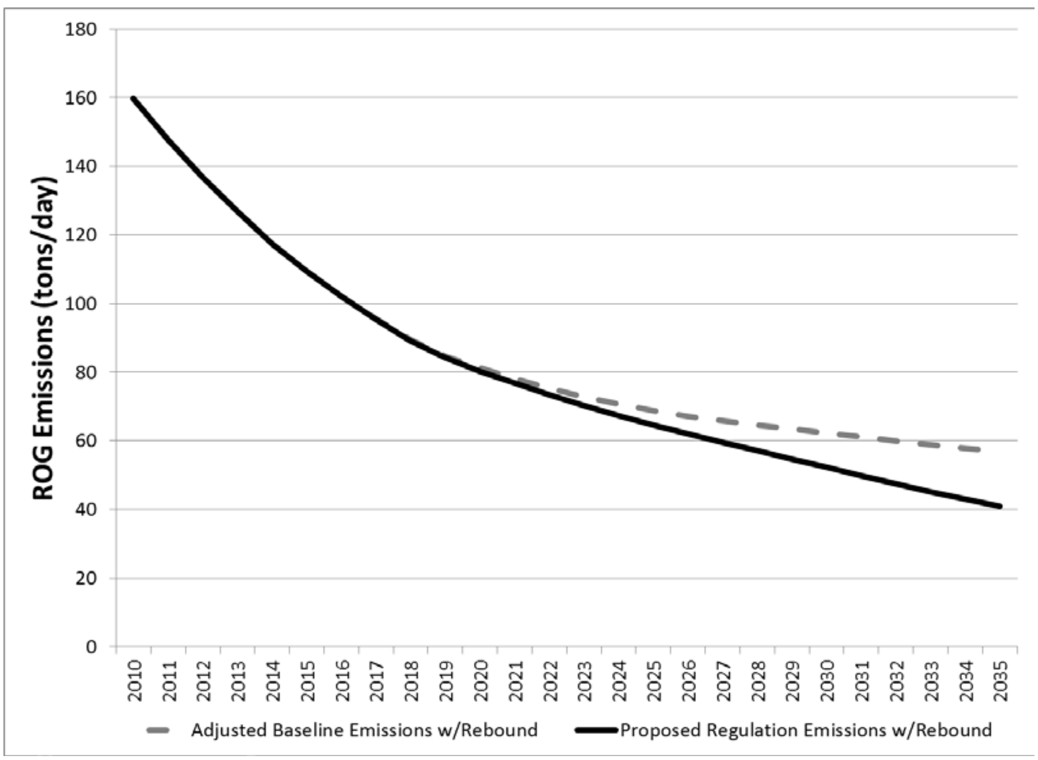


Figure 4-2. South Coast NOx Emissions: Baseline vs. Proposed Regulations

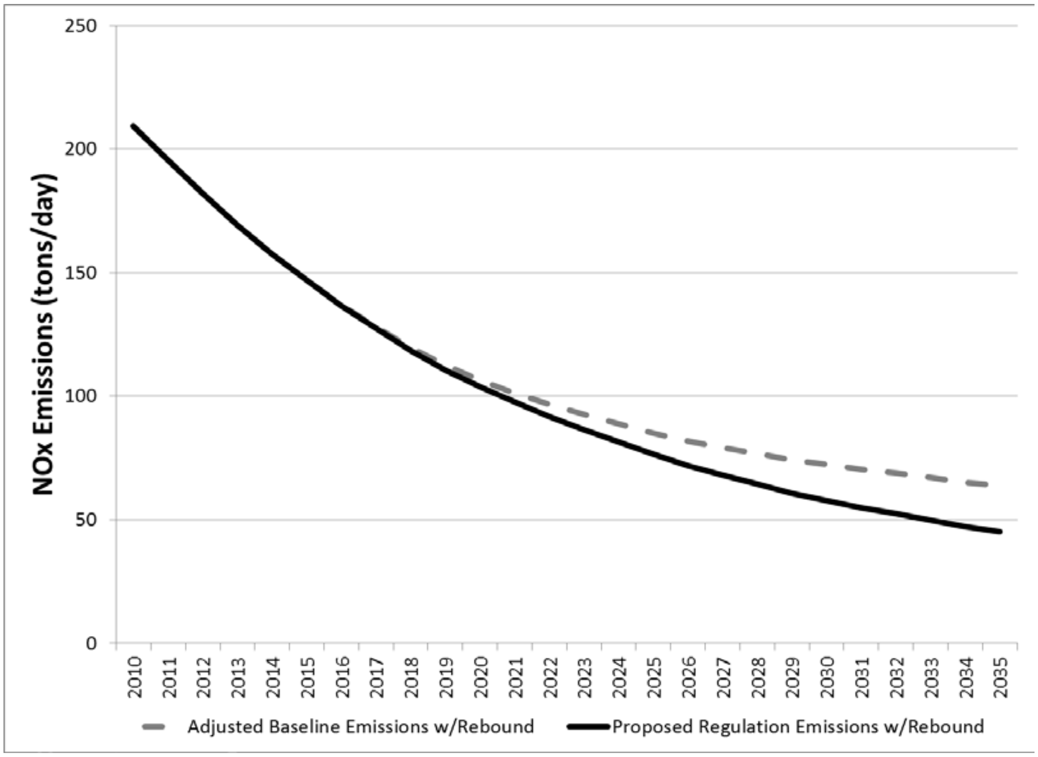


Figure 4-3. South Coast PM2.5 Emissions: Baseline vs Proposed Regulations

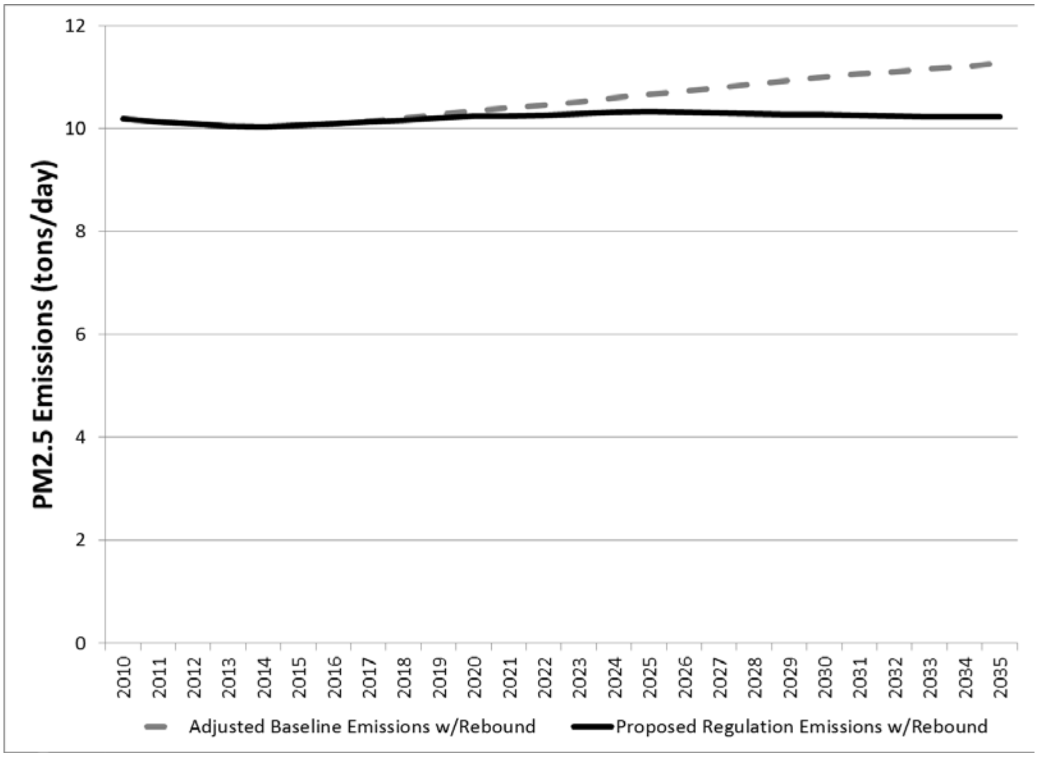
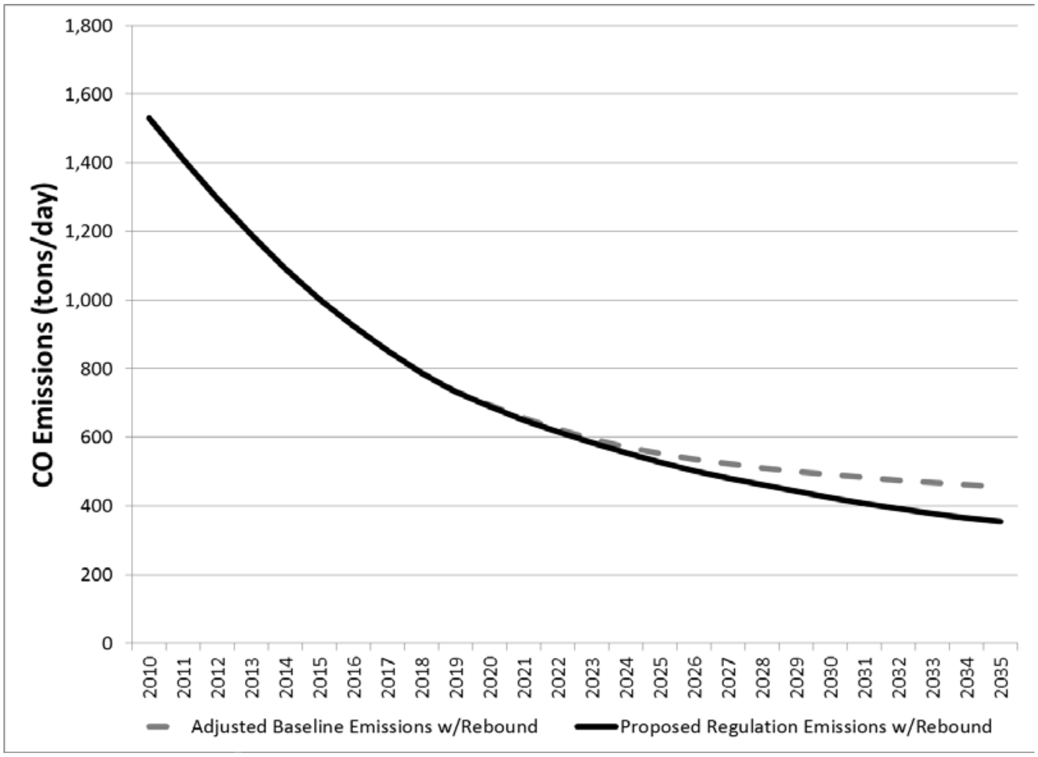


Figure 4-4. South Coast CO Emissions: Baseline vs Proposed Regulation



4.2 San Joaquin Valley

Figure 4-5, Figure 4-6, Figure 4-7, and Figure 4-8 show ROG, NOx, PM2.5, and CO emissions in the San Joaquin Valley. NOx and ROG reductions are similar in percentage to those seen in the South Coast and Statewide. PM2.5 emissions are increasing in the baseline more quickly in the San Joaquin Valley than in South Coast due to higher expected future VMT growth, and the percentage reduction estimated by the proposed regulation is similar to those seen in the South Coast and San Joaquin Valley. The proposed regulation is estimated to provide a 2 ton per day NOx reduction in 2023.

Figure 4-5. San Joaquin Valley ROG Emissions: Baseline vs Proposed Regulations

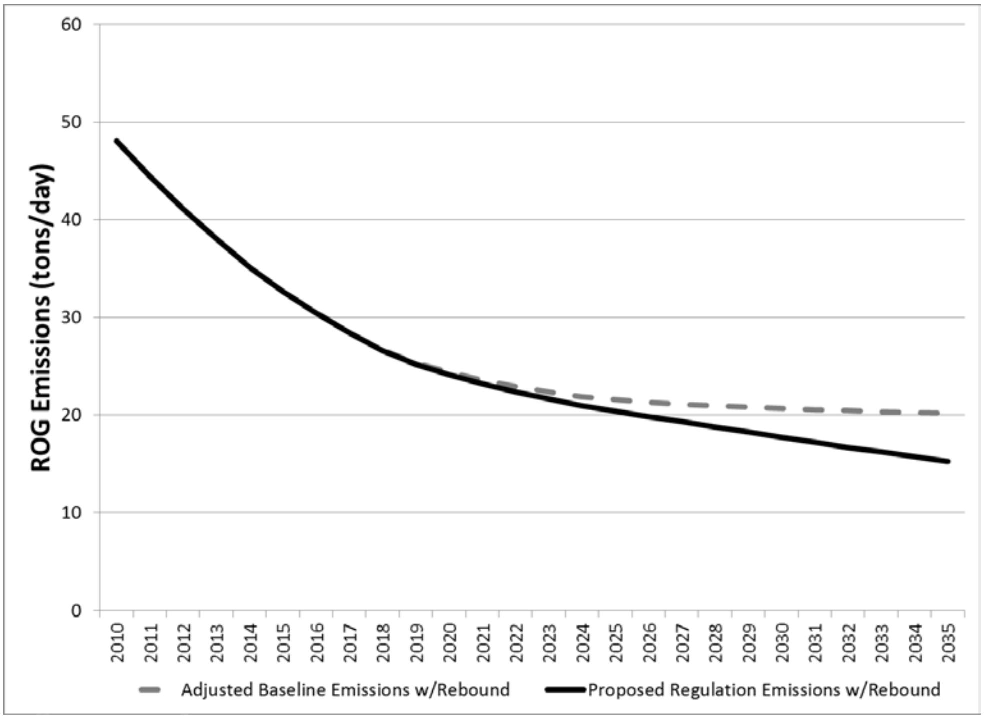


Figure 4-6. San Joaquin Valley NOx Emissions: Baseline vs Proposed Regulations

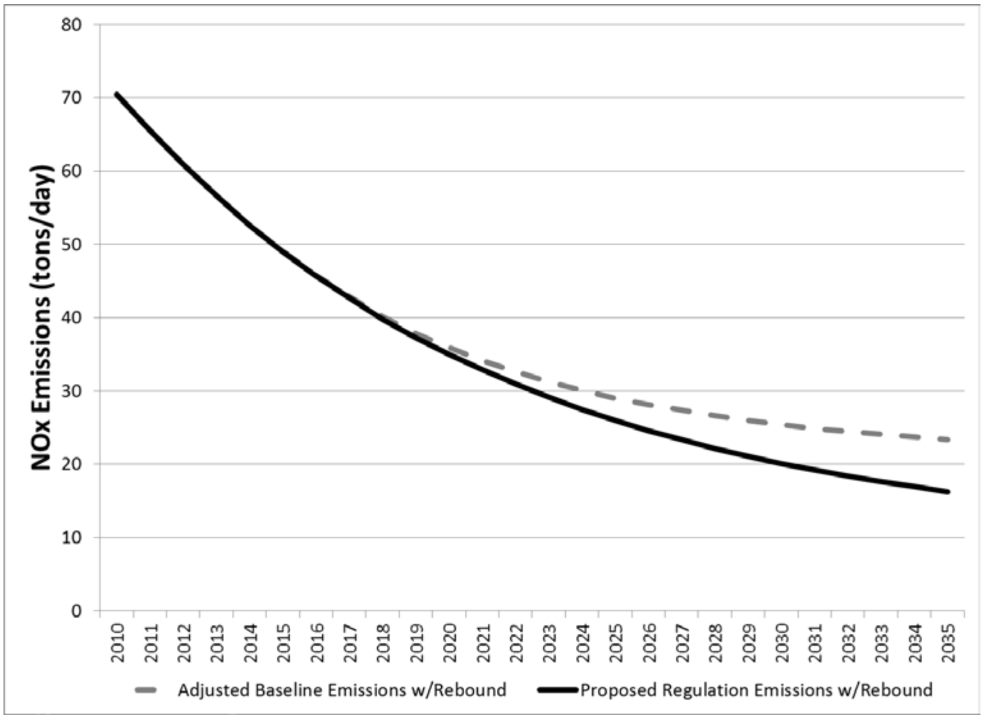


Figure 4-7. San Joaquin Valley PM2.5 Emissions: Baseline vs Proposed Regulations

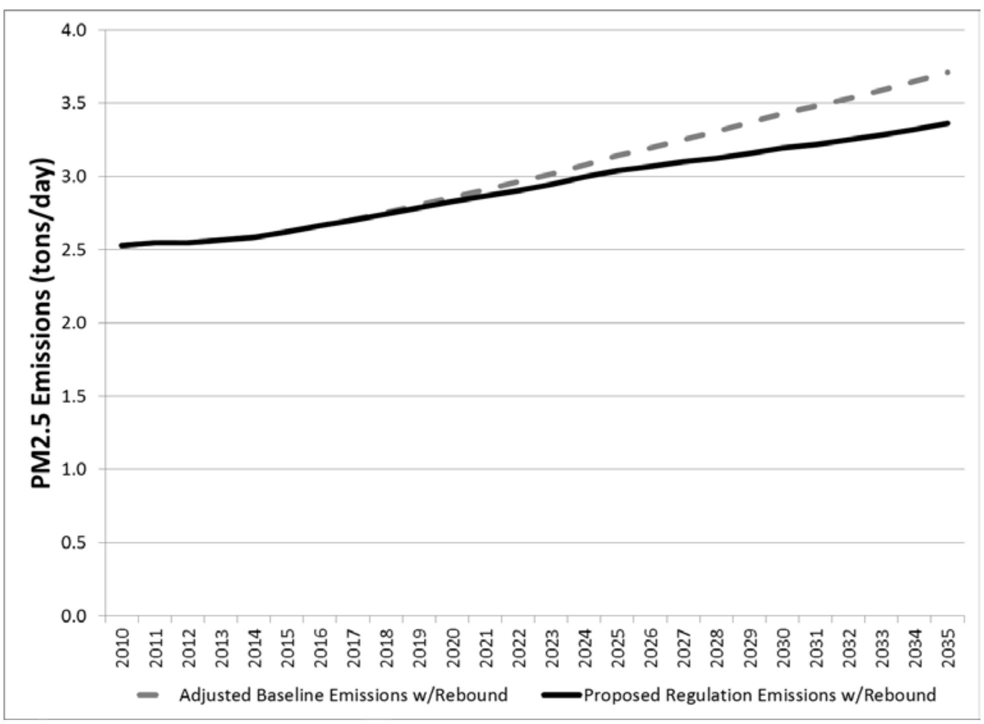
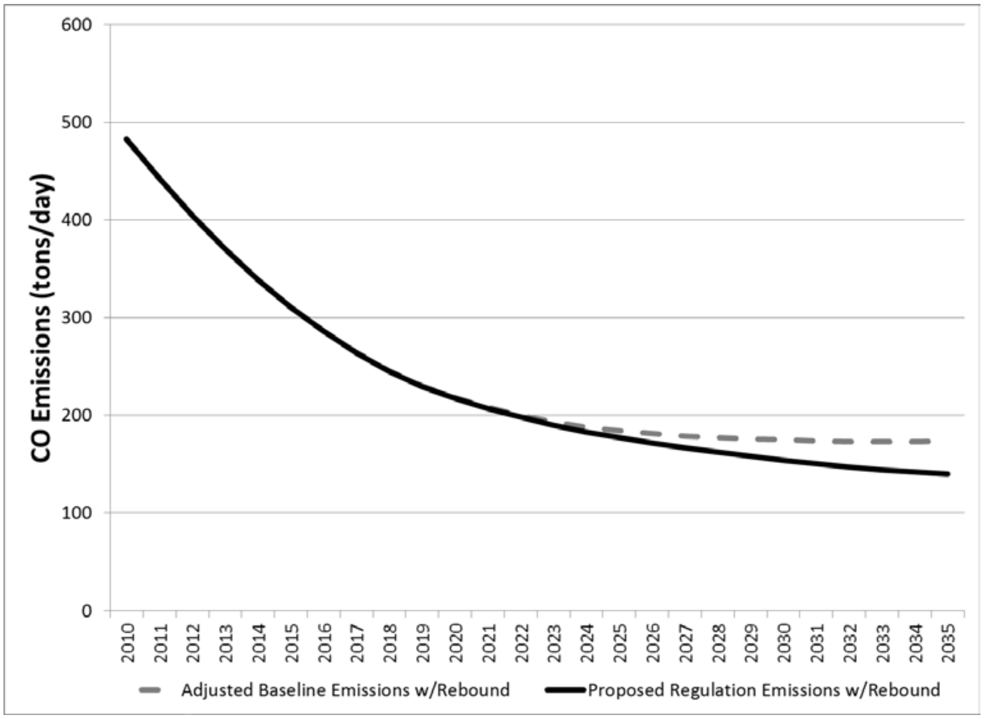


Figure 4-8. San Joaquin Valley CO Emissions: Baseline vs Proposed Regulations



5 Context and Need for Emissions Reductions

This chapter began with a statistic that there are currently roughly 25 million cars operating in California, and that by 2035 more than 30 million cars will be operating in California. Prior to the establishment of the Air Resources Board in 1968 photochemical smog pollution was a major health concern that caused major acute health impacts to Californians. Much of this smog was formed by automobile emissions. Over the next 40 years the Air Resources Board adopted the most stringent automobile emissions standards in the Country, requiring use of the catalytic converter that revolutionized emissions control and dramatically reduced emissions from automobiles. Those regulations, in conjunction with regional programs to reduce emissions from refineries, powerplants, and other stationary sources, led to a major improvement in air quality. In 1980, the South Coast Air Basin experienced widespread ozone levels which exceeded air quality standard for 179 days per year[13]. In 2010 that number was reduced to 63 days per year, and those violations occurred in a much smaller portion of the Air Basin. During this same period, peak ozone concentrations in Southern California

[13] 1997 federal 8-hour ozone standard of 0.08 ppm.

dropped more than 60percent - from 273 parts per billion (ppb) to 112 ppb. Similar air quality improvements were seen in many other regions of California.

Despite these major improvements air quality both the greater Los Angeles region and the San Joaquin Valley are classified by the U.S. Environmental Protection Agency (U.S. EPA) as “extreme” ozone non-attainment areas. This is the highest federal non-attainment classification, and these two areas of California are the only two areas of the nation granted this designation. Bringing these regions into attainment requires more significant emission controls than anywhere else in the United States.

In 2007, California adopted State Implementation Plans (SIPs) to chart the course to attainment of the 1997 federal 8-hour ozone standard. To achieve the 1997 ozone standard by the attainment date in 2023, NOx emissions in the greater Los Angeles region must be reduced by two thirds, even after considering all of the regulations in place today, with the most significant share of needed emission reductions will come from long-term advanced clean air technologies. In the San Joaquin Valley, the SIP identified the need to reduce NOx emissions by 80 tons/day in 2023 through the use of long-term and advanced technology strategies. To put this in context, this is equivalent to eliminating the NOx emissions from all on-road vehicles operating in these regions.

Despite the dramatic emission reductions and air quality improvements achieved to date, most urban areas of California, including Southern California, the Bay Area, and the Central Valley continue to exceed the federal ozone standard[14]. The ARB, the South Coast Air Quality Management District, and the San Joaquin Valley Air Pollution Control District are beginning to evaluate the emission reductions needed to attain the more health-protective ozone standard U.S. EPA established in 2008. In order to meet these challenges, air quality and land-use agencies in the South Coast and San Joaquin Valley must actively pursue a coordinated strategy that results in the widespread use of zero-emission technologies on transportation networks designed to reduce smog-forming emissions from single-occupant vehicle use.

The proposed Advanced Clean Car (ACC) regulation would reduce emissions from conventional gasoline vehicles to incredibly low levels. Over a typical vehicle’s 15 year lifetime ACC compliant cars would emit less than a pound of particulate matter, and less than 10 pounds of smog forming pollutants. The proposed regulation would also continue ARB’s commitment to zero emission technologies, requiring roughly 6percent of vehicles sold in California to be true zero emission vehicles. Through that mandate, ZEV technologies will continue to improve and expand into wider applications, making

[14] 2008 federal 8-hour ozone standard of 0.075 ppm. Designations, classifications, attainment date and planning requirements for the 2008 federal ozone standard have not yet been established by the U.S. Environmental Protection Agency. ARB anticipates that State Implementation Plans (SIPs) will be due to U.S. EPA by 2015 with attainment required in the 2031/32 timeframe.

them a viable option for many consumers in California. The proposed ACC regulation achieves maximum feasible emission reductions from automobiles and places the State on a continuing path to ultimately meet national ambient air quality standards.

In 2006 the legislature adopted Assembly Bill 32 which outlined California's major initiatives to reduce GHG emissions, and set an emissions reduction target of meeting 1990 emissions levels by 2020, which is a reduction of roughly 30percent. In 2005 then Governor Schwarzenegger established an emissions reduction target of achieving an 80 percent reduction in 1990 GHG emissions levels by 2050. In December 2008 the Board adopted ARB's Scoping Plan which outlined the initiatives that will be implemented to reach the 2020 GHG emissions target. The proposed ACC regulation is a major component of the Scoping Plan.

In addition to meeting ozone air quality standards, achieving an 80percent reduction in GHG emissions by 2050 will also require widespread electrification of transportation networks in California. The proposed ACC regulation and associated ZEV mandate continues ARB's path towards meeting long term GHG emissions goals.

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