Appendix F:

Technical Methodology for the Roadmap Air Pollutant Analysis

Contents

1 Introduction

This appendix outlines the methodology used to estimate the near-term (2035) and long-term (2045) reductions in air pollutants in the San Diego Regional Climate Action Roadmap (Roadmap). Reduction estimates were developed for the transportation, electricity, and building sectors where sufficient data, assumptions, and tools were available. Measures without adequate data or quantification tools were not included in this analysis. The air pollutant analysis addresses Roadmap measures that account for over 80% of the region's greenhouse gas emissions.

2 Transportation

For the transportation sector, Table F.1 below summarizes the total estimated reductions in criteria air pollutants from all transportation measures combined. Air pollutant reductions associated with measures that reduce vehicle miles traveled (VMT) are summarized in Table F.2, including increasing public transit use (T-1), enhancing active transportation (T-2), expanding flexible fleets (T-3), and promoting transportation demand management (TDM) strategies such as teleworking (T-4). Air pollutant impacts of adopting zero-emission vehicles (ZEV) (T-5) are presented in Table F.3. Reductions associated with decreasing fuel use from idling (T-6) were not quantified due to data limitations. VMT reduction assumptions for each measure are described in Appendix E (Table E.1, E.2, E.3, E.4). Pollutant emission factors were obtained from the California Air Resources Board's (CARB) EMissions FACtors (EMFAC) 2025 model for San Diego County.[1] For VMT-reduction measures (T-1 through T-4), emission factors were averaged across gasoline light-duty vehicles (LDVs) and medium-duty vehicles (MDVs). For ZEV adoption (T-5), emission factors were averaged across gasoline and diesel LDVs, MDVs, heavy-duty vehicles (HDVs), and buses. Air pollutants quantified include sulfur oxides (SO_x), nitrogen oxides (NO_x, with NO_2 represented as a subset), fine and coarse particulate matter ($PM_{2.5}$, PM_{10}), carbon monoxide (CO), and volatile organic compounds (VOCs). These pollutants were quantified based on the availability of corresponding emission factors in EMFAC. Avoided emissions were calculated by multiplying the annual VMT reductions for T-1 through T-4, and the electrified VMT (e-VMT) for T-5, by the relevant emission factor for each pollutant. Results were converted from grams to metric tons (MT) per year.

[1] **EMFAC 2025 v2.0.0**, (California Air Resources Board, 2025).

Table F.1 below summarizes the total estimated reductions in criteria air pollutants from all transportation measures combined, as calculated with averaged EMFAC 2025 emission factors.

Table F.1: Air Pollutant Reductions from Transportation Measures

Roadmap Estimated Air Pollutant Reductions from Transportation Measures in Metric Tons (MT)		
Year	**2035**	**2045**
VOCs	162.21	454.83
$PM_{2.5}$	6.58	9.63
PM_{10}	7.26	10.28
NO_x	295.68	492.51
SO_x	4.85	7.90
CO	10,075.23	18,360.72

Table F.2 presents pollutant reductions for measures that reduce VMT (T-1 through T-4), as calculated with averaged EMFAC 2025 emission factors.

Table F.2: Air Pollutant Reductions from Measures T-1, T-2, T-3, and T-4

Roadmap Estimated Air Pollutant Reductions from Transportation Measures T-1, T-2, T-3, and T-4 in MT								
Measure	**T-1**		**T-2**		**T-3**		**T-4**	
Year	**2035**	**2045**	**2035**	**2045**	**2035**	**2045**	**2035**	**2045**
VOCs	59.45	216.58	38.22	91.12	41.92	75.17	18.19	66.97
$PM_{2.5}$	2.24	4.34	1.44	1.83	1.58	1.51	0.69	1.34
PM_{10}	2.49	4.64	1.60	1.95	1.75	1.61	0.76	1.43
NO_x	94.57	224.47	60.79	94.44	66.68	77.91	28.94	69.42
SO_x	1.71	3.65	1.10	1.54	1.20	1.27	0.52	1.13
CO	3,750.63	8,875.79	2,411.09	3,692.11	2,644.78	3,045.98	1,147.78	2,713.84

Table F.3 shows reductions from zero-emission vehicle adoption (T-5), which were modeled separately due to the distinct EMFAC emission factors for electric vehicles, as calculated with averaged 2025 EMFAC emission factors.

Table F.3: Air Pollutant Reductions from Measure T-5

Roadmap Estimated Air Pollutant Reductions from Measure T-5 in MT		
Year	**2035**	**2045**
VOCs	4.42	4.99
$PM_{2.5}$	0.63	0.62
PM_{10}	0.66	0.65
NO_x	44.69	26.28
SO_x	0.32	0.32
CO	120.94	133.00

Table F.4 lists the average EMFAC 2025 emission factors (milligrams per mile) used to determine air pollutant reductions for the transportation sector under each measure.

Table F.4: EMFAC 2025 Emission Factors For Measures T-1, T-2, T-3, T-4, and T-5

Averaged EMFAC 2025 Emission Factors (milligrams/mile)				
Measure(s)	**T-1, T-2, T-3, and T-4**		**T-5**	
Year	**2035**	**2045**	**2035**	**2045**
VOCs*	60.95	109.75	46.90	51.13
$PM_{2.5}$	2.30	2.20	6.68	6.30
PM_{10}	2.55	2.35	7.04	6.61
NO_x	96.95	113.75	474.34	268.99
SO_x	1.75	1.85	3.43	3.28
CO	3,845.15	4,447.15	1,238.58	1,361.53

*EMFAC2025 reports reactive organic gas (ROG) emissions. Because the EMFAC2025 User's Guide states that the ROG class is the same as the EPA's VOCs definition, VOC results are reported here.

3 Electricity

This section describes the methodology used to estimate air pollutant reductions associated with decarbonizing the regional electric grid. This analysis also considers the expected increase in electricity demand from building electrification and ZEV charging needs in the near-term. Air pollutant reductions linked to the decarbonization of the regional electrical grid (E-1) were estimated in Table F.5 using the Environmental Protection Agency's (EPA) AVoided Emissions and geneRation Tool (AVERT).[2] AVERT evaluates how changes in electricity generation such as increased energy efficiency, renewable energy, and electric vehicles impact emissions from electric power plants at a county, state, or regional scale. The tool is limited to quantifying specific air pollutants, including VOCs, $PM_{2.5}$, NH_3, NO_x, and sulfur dioxide (SO_2). Distributed energy resources (DER) were assumed to displace approximately 908 gigawatt hours (GWh) of fossil fuel electricity generation in 2035, based on the analysis done by University of San Diego School of Law's Energy Policy Initiatives Center (USD EPIC) in Appendix E (Table E.7). AVERT was run for the California region using 2022 as the base year. The tool provides California-specific emission factors (lbs per megawatt-hour[MWh] displaced) for each air pollutant (Table F.6), which were applied to the avoided generation value. Results were scaled to San Diego County and converted into MT. Table F.5 shows the results of the AVERT analysis, while Table F.6 lists the emission factors (lbs per MWh displaced) used for each pollutant type.

Table F.5: Air Pollutant Reductions from Electricity

Roadmap Estimated Air Pollutant Reductions from Electricity in MT		
Year	**2035**	**2045***
VOCs	0.57	0
$PM_{2.5}$	1.81	0
NH_3	1.16	0
NO_x	1.60	0
SO_2	0.12	0

* Air pollutant reductions from Measure E-1 are estimated to be zero in 2045, as the electricity load of all regional sources is targeted to be 100% renewable in 2045.
AVERT rounds results to the nearest 10 lbs/year.

[2] **Avoided Emissions and Generation Tool (AVERT) v4.3**, (EPA, 2024).

Table F.6: AVERT Emission Factors

AVERT Emission Factors	
Air Pollutant	**lbs/MWh**
VOCs	0.01
$PM_{2.5}$	0.04
NH_3	0.03
NO_x	0.26
SO_2	0.04

4 Buildings

The reduction of air pollutants from the building sector was estimated based on the decrease of onsite natural gas use from energy efficiency and electrification measures (B-1, B-2). This analysis uses the assumptions for changes in residential and non-residential building natural gas and propane consumption that are provided in Appendix E (Table E.8). Air pollutant reductions were calculated by applying the emission factors from the EPA's Compilation of Air Pollutant Emission Factors from Stationary Sources (AP-42)[3,4] to therms of natural gas and million British thermal units (MMBtu) of propane. Quantifications were limited to pollutants with available emission factors, which included VOCs, PM, NO_x, SO_x, and CO. For natural gas, emission factors were available for all of these pollutants, while for propane, emission factors were not available for VOCs and SO_2. Air pollutant reductions were estimated by multiplying the AP-42 emission factors by the amount of natural gas and propane avoided. Table F.7 presents estimates of reductions in air pollutants from decreased use of natural gas and propane in buildings, calculated using AP-42 emission factors. Table F.8 lists AP-42 emission factors for natural gas (lb per MMBtu) and propane (lb per MMBtu).

[3] **AP-42, Fifth Edition, Volume I Chapter 1: External Combustion Sources**, Table 1.4-1 - Table 1.4-2, (EPA, 1998).

[4] **AP-42, Fifth Edition, Volume I Chapter 1: External Combustion Sources**, Table 1.5-1, (EPA, 2025).

Table F.7: Air Pollutant Reductions from Building Measures

Roadmap Estimated Air Pollutant Reductions from Buildings in Metric Tons (MT)						
Fuel Type	**Natural Gas**		**Propane**		**Total**	
Year	**2035**	**2045**	**2035**	**2045**	**2035**	**2045**
VOCs	53.32	94.17	-	-	53.32	94.17
PM	73.68	130.12	1.31	2.32	74.99	132.45
NO_x	911.29	1,609.38	24.36	43.18	935.65	1,652.56
SO_2	5.82	10.27	-	-	5.82	10.27
CO	387.78	684.84	14.05	24.91	401.84	709.75

Table F.8: AP-42 Emission Factors for Natural Gas and Propane

AP-42 Emission Factors (lbs/MMBtu)		
Fuel Type	**Natural Gas**	**Propane**
VOCs	0.0054	-
PM	0.0075	0.0077
NO_x	0.0922	0.1421
SO_2	0.0006	-
CO	0.0392	0.0820