California High-Speed Rail Authority

Bakersfield to Palmdale Project Section

Draft Project Environmental Impact Report/ Environmental Impact Statement

Appendix 3.6-A: Energy Analysis Memorandum

January 2020

CALIFORNIA High-Speed Rail Authority

The environmental review, consultation, and other actions required by applicable Federal environmental laws for this project are being or have been carried out by the State of California pursuant to 23 U.S.C. 327 and a Memorandum of Understanding dated July 23, 2019, and executed by the Federal Railroad Administration and the State of California.

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Memorandum

DATE: Issued: November 16, 2016
Rev.#1: November 23, 2017
Rev.#2: March 27, 2017

TO: Authority and Regional Consultant Environmental Staff

FROM: Alice Lovegrove and Eddie Tadross, WSP Parsons Brinckerhoff

CC: Lisa Nungesser and Bryan Porter

SUBJECT: California High-Speed Rail Statewide Criteria Pollutant, GHG and Energy Analysis

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This revised version of the memo includes a discussion of statewide energy consumption for on-road vehicles, aircraft, and electrical energy that would change with future operation of the project. In addition, the statewide Excel spreadsheet summaries that accompany this memo have also been updated. Should you have any questions, please contact Alice Lovegrove at Lovegrove@pbworld.com or Eddie Tadross at Tadross@pbworld.com.

Overview

This memo describes the calculation of statewide criteria pollutant and greenhouse gas (GHG) emission levels associated with future operation of the California High-Speed Rail Project. This memo is meant to accompany Excel spreadsheet files with statewide summary emission data for the following high-speed rail (HSR) sections: San Francisco to San Jose, San Jose to Merced, Bakersfield to Palmdale, Palmdale to Burbank, Burbank to Los Angeles, and Los Angeles to Anaheim. An earlier analysis of emission levels for the Merced to Fresno and Fresno to Bakersfield HSR sections was completed several years ago.

The spreadsheets consist of multiple tables. The list below explains what is included as part of each spreadsheet file.

- MED - EX(2015) & EX+PROJ = Medium Alternative 2015 (Existing & Existing Plus Project)
- MED - 2029 NB&BD = Medium Alternative 2029 (No Build & Build)
- MED - 2040 NB&BD = Medium Alternative 2040 (No Build & Build)
- MED EXT - EX(2015) & EX+PROJ = Medium Extended Alternative 2015 (Existing & Existing Plus Project)
- MED EXT - 2029 NB&BD = Medium Extended Alternative 2029 (No Build & Build)
- MED EXT - 2040 NB&BD = Medium Extended Alternative 2040 (No Build & Build)
- HIGH - EX(2015) & EX+PROJ = High Alternative 2015 (Existing & Existing Plus Project)
- HIGH - 2029 NB&BD = High Alternative 2029 (No Build & Build)
- HIGH - 2040 NB&BD = High Alternative 2040 (No Build & Build)

Provided below is a description of the emission calculations. You can also use this text in preparing the air quality section for your HSR section environmental impact report/environmental impact statement (EIR/EIS).

Statewide and Regional Operational Emissions Calculations

The emission burden analysis of a project determines a project's overall impact on air quality levels. The project section would affect long-distance, city-to-city travel along freeways and highways throughout the state, as well as long-distance, city-to-city aircraft takeoffs and landings. The HSR system would also affect electrical demand throughout the state. Analysts calculated criteria pollutant and GHG operational emissions for three ridership scenarios: a medium ridership scenario of the Silicon Valley to Central Valley line (from San Jose to North of Bakersfield), a medium ridership scenario of an extended Silicon Valley to Central Valley line (from San Francisco to Bakersfield), and a high ridership scenario of the Silicon Valley to Central Valley line for Existing (2015) and Phase 1 of Statewide High-Speed Rail Build Out (2040) years. All applicable scenarios are based on the level of ridership as presented in the Authority's *2016 Business Plan* (Authority 2016). The tables in the effects analysis therefore present three values for operational emissions for each pollutant, corresponding to these three scenarios.

On-Road Vehicles

Analysts evaluated on-road vehicle emissions using average daily VMT estimates and associated average daily speed estimates for each affected county. Analysts estimated emission factors using the emission factors using the California Air Resources Board (CARB) emission factor program, EMission FACtors 2014 (EMFAC2014), which accounts for existing regulations that would reduce emissions, such as the Pavley Clean Car Standards. Parameters were set in the program for each individual county to reflect conditions within each county and statewide parameters to reflect travel through each county. The analysis was conducted for the following modeling years:

- Existing (Year 2015)
- Opening Year (Year 2029)
- Horizon Year (Year 2040)

To determine overall pollutant burdens generated by on-road vehicles, analysts multiplied the estimated VMT by the applicable pollutant's emission factors, which are based on speed, vehicle mix, and analysis year.

Aircraft

Analysts used the Federal Aviation Administration's Aviation Environmental Design Tool (AEDT) to estimate aircraft emissions. This tool estimates the emissions generated from specified numbers of landing and take-off cycles. Along with emissions from the aircraft themselves, emissions generated from associated ground maintenance requirements are included. Analysts calculated average aircraft emissions based on the profile of aircraft currently servicing the San Francisco to Los Angeles corridor. Analysts estimated the number of air trips removed attributable to the HSR using the results of the travel demand modeling analyses conducted for the project section, based on the ridership estimates presented in the California High-Speed Rail Authority's *2016 Business Plan* (Authority 2016).

Power Plants

Analysts conservatively estimated the electrical demands caused by propulsion of the trains and the trains at terminal stations and in storage depots and maintenance facilities as part of the project section design. Analysts derived average emission factors for each kilowatt-hour required from CARB statewide emission inventories of electrical and cogeneration facilities data along with USEPA eGRID2012 (released 10/2015) electrical generation data. The energy estimates used in this analysis for the propulsion of the HSR include the use of regenerative brake power.

The HSR system is currently analyzed as if it would be powered by the state's current electric grid. This is a conservative assumption because of the state requirement that an increasing fraction of electricity (50 percent by 2030) generated for the state's power portfolio come from renewable energy sources. As such, the emissions generated for the HSR system are expected to be lower in the future than the emissions estimated for this analysis. Furthermore, under the 2013 Policy Directive POLI-PLAN-03, the Authority has adopted a goal to purchase 100 percent of the HSR system's power from renewable energy sources.

Greenhouse Gas Analysis

As discussed in Section XX [of the EIR/EIS], Definition of Resource Study Area, the project section would reduce long-distance, city-to-city travel along freeways and highways throughout the state, as well as long-distance, city-to-city aircraft takeoffs and landings. The project section would also affect electricity demand throughout the state. These elements would affect GHG emissions in both the statewide and regional study areas. The methodology for estimating GHG emissions associated with operations of the project section is discussed below.

On-road Vehicle Emissions

Analysts conducted the on-road vehicle GHG emission analysis using the same methods and RSAs as described for air quality emission calculations in Section X, On-Road Vehicles.

Aircraft Emissions

Analysts calculated aircraft emissions by using the fuel consumption factors and emission factors from the CARB's 2000–2014 *Greenhouse Gas Emissions Inventory Technical Support Document* and the accompanying technical support document. The emission factor includes both landing and take-off and cruise operations (formula: aircraft emissions per flight = fuel consumption × emission factor; aircraft emissions = flights removed × aircraft emissions per flight). Analysts calculated average aircraft GHG emissions based on the profile of intrastate aircraft currently servicing the San Francisco to Los Angeles corridor. Analysts estimated the number of air trips removed attributable to the project section through the travel demand modeling analysis conducted for the project section, based on the ridership estimates presented in the Authority's *2016 Business Plan* (Authority 2016).

Power Plant Emissions

The electrical demands due to propulsion of the trains, stations, storage depots and maintenance facilities were calculated as part of the project design. Average GHG emission factors for each kilowatt-hour required were derived from USEPA eGRID2012 electrical generation data. The energy estimates used in this analysis for the propulsion of the HSR include the use of regenerative brake power.

In addition, because of the state requirement that an increasing fraction (50 percent by 2030) of electricity generated for the state's power portfolio come from renewable energy sources, the emissions generated for the HSR system are expected to be lower in the future when compared to emissions estimated for this analysis.

Energy Analysis

As discussed in Section XX [of the EIR/EIS], Definition of Resource Study Area, the project section would reduce long-distance, city-to-city travel along freeways and highways throughout the state, as well as long-distance, city-to-city aircraft takeoffs and landings. The project section would also affect electricity demand throughout the state. These elements would affect energy in both the statewide and regional study areas. The methodology for estimating energy associated with operation of the project section is discussed below.

On-road Vehicle Energy Usage

Analysts conducted the on-road vehicle energy analysis using the same inputs and RSAs as described for air quality emission calculations in Section X, Energy rates were determined through the use of carbon balance equations as recommended by CARB.

Aircraft Energy Usage

Analysts calculated aircraft energy use by using the fuel consumption factors from the CARB's 2000–2014 *Greenhouse Gas Emissions Inventory Technical Support Document* and the accompanying technical support document. The energy use includes both landing and take-off and cruise operations (formula: aircraft energy per flight = fuel consumption × btu/gallon of fuel; aircraft energy = flights removed × aircraft energy per flight). Analysts calculated average aircraft energy based on the profile of intrastate aircraft currently servicing the San Francisco to Los Angeles corridor. Analysts estimated the number of air trips removed attributable to the project section through the travel demand modeling analysis conducted for the project section, based on the ridership estimates presented in the Authority's *2016 Business Plan* (Authority 2016).

Energy Usage

The electrical demands due to propulsion of the trains, stations, storage depots and maintenance facilities were calculated as part of the project design. Analysts estimated the energy use based on the ridership estimates and train operating characteristics as presented in the Authority's *2016 Business Plan* (Authority 2016).

Segment Los Angeles to Anaheim | Input Year: 2015 | Input Energy Type: eGRID | Scenario: Medium Scenario

GHG&Energy Report Tables Project Build year base: 2033

Source	County	Existing	EX + Project	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes Emissions (million metric tons/year), MMBTU		
		Annual VMT	Annual VMT	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Roadway	LOS ANGELES	73,394,193,078	72,724,087,184	23.6	23.9	347,951,386.5	23.4	23.7	344,774,510.1	-0.2	-0.2	-3,176,876.3
	ORANGE	23,850,547,795	23,717,213,976	7.4	7.6	109,819,611.1	7.4	7.5	109,205,676.8	0.0	0.0	-613,934.3
	SAN BERNARDINO	12,725,201,965	12,665,228,642	3.8	3.9	56,466,931.1	3.8	3.9	56,200,804.9	0.0	0.0	-266,126.2
	RIVERSIDE	17,712,108,321	17,633,058,738	5.4	5.4	79,179,768.6	5.3	5.4	78,826,387.3	0.0	0.0	-353,381.3
	SAN DIEGO	4,042,766,953	3,943,468,261	1.2	1.3	18,299,311.9	1.2	1.2	17,849,843.1	0.0	0.0	-449,468.8
	IMPERIAL	612,732,446	609,551,747	0.2	0.2	2,679,263.3	0.2	0.2	2,665,355.3	0.0	0.0	-13,908.1
	SANTA BARBARA	864,545,016	840,246,898	0.3	0.3	3,913,304.7	0.3	0.3	3,803,320.9	0.0	0.0	-109,983.8
	Regional Total	133,202,095,575	132,132,855,445	41.9	42.5	618,309,577.3	41.6	42.2	613,325,898.5	-0.3	-0.3	-4,983,678.8
	Statewide Total	205,015,920,154	201,584,933,649	63.0	64.0	930,015,062.9	62.0	62.9	914,451,056.3	-1.1	-1.1	-15,564,006.6

Source	Area	Existing	EX + Project	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes Emissions (million metric tons/year), MMBTU		
		# of Flights	# of Flights	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Planes	Southern California	107,915	73,378	0.9	0.9	12,947,020.2	0.6	0.6	8,803,488.3	-0.3	-0.3	-4,143,531.9
	Statewide	268,567	188,430	2.3	2.3	32,221,206.1	1.6	1.6	22,606,829.5	-0.7	-0.7	-9,614,376.6

Source	Area	Existing	EX + Project	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes in Emissions (million metric tons/year), MMBTU		
		Energy Use	Energy Use	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Energy - eGRID	Los Angeles to Anaheim			N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.0	47,044.2
	Statewide			N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.5	1,568,139.3

Totals	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes in Emissions (million metric tons/year), MMBtu		
	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Regional	42.8	43.5	631,256,597.4	42.2	42.8	622,129,386.8	-0.6	-0.6	-9,080,166.5
Statewide	65.3	66.3	962,236,269.0	63.6	64.5	937,057,885.8	-1.3	-1.3	-23,610,243.9

Criteria Report Tables

Source	County	Existing	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		Annual VMT	Annual VMT	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Roadway	LOS ANGELES	73,394,193,078	72,724,087,183.88	2,954	3,993	119,083	11,968	292	3,762	8,309	1,574	2,257	2,927	3,956	117,995	11,859	289	3,727	8,233	1,560	2,236	-27	-36	-1087	-109	-3	-34	-76	-14	-21
	ORANGE	23,850,547,795	23,717,213,976	924	1,247	37,951	3,881	95	1,220	2,699	509	731	919	1,240	37,739	3,859	94	1,213	2,684	507	727	-5	-7	-212	-22	-1	-7	-15	-3	-4
	SAN BERNARDINO	12,725,201,965	12,665,228,642	469	632	19,523	2,081	51	649	1,433	270	388	467	629	19,431	2,071	50	646	1,427	269	386	-2	-3	-92	-10	0	-3	-7	-1	-2
	RIVERSIDE	17,712,108,321	17,633,058,738	659	889	27,419	2,891	71	904	2,001	376	541	656	885	27,296	2,878	70	900	1,993	375	539	-3	-4	-122	-13	0	-4	-9	-2	-2
	SAN DIEGO	4,042,766,953	3,943,468,261	149	200	5,701	699	16	207	456	86	123	145	195	5,561	681	16	202	445	83	120	-4	-5	-140	-17	0	-5	-11	-2	-3
	IMPERIAL	612,732,446	609,551,747	22	30	900	102	2	31	70	13	19	22	30	896	102	2	31	69	13	19	0	0	-5	-1	0	0	0	0	0
	SANTA BARBARA	864,545,016	840,246,898	32	43	1,219	149	3	44	97	18	26	31	42	1,185	145	3	43	95	18	26	-1	-1	-34	-4	0	-1	-3	-1	-1
	Regional Total	133,202,095,575	132,132,855,445	5,209	7,035	211,796	21,772	530	6,817	15,066	2,847	4,085	5,167	6,978	210,104	21,596	526	6,762	14,945	2,824	4,052	-42	-57	-1,693	-176	-4	-55	-121	-23	-33
	Statewide Total	205,015,920,154	201,584,933,649	7,785	10,506	323,019	33,326	816	10,518	22,977	4,369	6,238	7,654	10,330	317,613	32,769	802	10,342	22,592	4,295	6,133	-130	-176	-5406	-558	-14	-176	-385	-73	-104

Source	Area	No Project	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		# of Flights	# of Flights	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5
Planes	Southern California	107,915	73,378	136	137	1,161	1,116	120	34	34	34	34	92	93	789	759	82	23	23	23	23	-43	-44	-371	-357	-38	-11	-11	-11	-11
	Statewide	268,567	188,430	338	341	2,888	2,779	299	84	84	84	84	237	239	2,027	1,949	210	59	59	59	59	-101	-102	-862	-829	-89	-25	-25	-25	-25

Source	Area	No Project	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5
Energy	Los Angeles to Anaheim			328	1,808	2,890	2,312	120	325			322	328	1,811	2,897	2,315	120	326	326	323	323	0	4	6	3	1	1	1	1	1
	Statewide			1,646	16,458	29,616	15,531	2,303	2,953			2,683	1,659	16,582	29,823	15,636	2,320	2,976	2,976	2,704	2,704	12	124	207	105	17	23	23	21	21

Total	Area	No Project	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
	Regional			5,672	8,979	215,848	25,200	770	7,176	15,099	2,881	4,441	5,587	8,883	213,790	24,670	728	7,111	15,293	3,170	4,398	-85	-97	-2058	-530	-42	-65	-131	-33	-43
	Statewide			9,768	27,305	355,523	51,636	3,418	13,555	23,061	4,452	9,004	9,550	27,152	349,462	50,354	3,332	13,377	25,627	7,058	8,896	-219	-153	-6061	-1281	-86	-178	-387	-77	-108

** With entrained roadway dust*

Segment Los Angeles to Anaheim | Input Year: 2040 | Input Energy Type: eGRID | Scenario: Medium Scenario

GHG&Energy Report Tables

Source	County	No Project	Build	Total No Build Emissions (million metric tons/year), MMBTU			Total Build Emissions (million metric tons/year), MMBTU			Changes Emissions (million metric tons/year), MMBTU		
		Annual VMT	Annual VMT	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Roadway	LOS ANGELES	86,055,909,405	85,124,593,011	13.8	14.0	226,120,675.3	13.7	13.9	223,673,546.5	-0.1	-0.2	-2,447,128.8
	ORANGE	27,531,689,116	27,346,381,133	4.3	4.4	70,776,918.3	4.3	4.4	70,300,538.9	0.0	0.0	-476,379.3
	SAN BERNARDINO	18,495,252,023	18,411,900,811	2.9	2.9	47,192,871.9	2.9	2.9	46,980,191.2	0.0	0.0	-212,680.7
	RIVERSIDE	28,519,428,527	28,409,565,036	4.4	4.5	72,775,622.3	4.4	4.5	72,495,273.6	0.0	0.0	-280,348.7
	SAN DIEGO	5,386,124,914	5,248,119,114	0.9	0.9	14,123,478.6	0.8	0.9	13,761,600.3	0.0	0.0	-361,878.3
	IMPERIAL	1,033,072,252	1,028,651,701	0.2	0.2	2,690,515.4	0.2	0.2	2,679,002.6	0.0	0.0	-11,512.8
	SANTA BARBARA	1,038,912,666	1,005,143,024	0.2	0.2	2,742,740.6	0.2	0.2	2,653,588.3	0.0	0.0	-89,152.2
	Regional Total	168,060,388,904	166,574,353,829	26.6	27.0	436,422,822.3	26.4	26.8	432,543,741	-0.2	-0.2	-3,879,080.9
	Statewide Total	261,252,464,970	256,484,063,423	41.3	41.9	676,564,593.2	40.8	41.5	669,076,952.7	-0.5	-0.5	-7,487,640.5

Source	Area	No Project	Build	Total No Build Emissions (million metric tons/year), MMBTU			Total Build Emissions (million metric tons/year), MMBtu			Changes Emissions (million metric tons/year), MMBTU		
		# of Flights	# of Flights	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Planes	Southern California	149,961	101,962	1.3	1.3	17,991,503.2	0.9	0.9	12,232,802.6	-0.4	-0.4	-5,758,700.6
	Statewide	380,189	268,814	3.3	3.3	45,612,947.3	2.3	2.3	32,250,840.4	-1.0	-1.0	-13,362,106.9

Source	Area	No Project	Build	Total No Build Emissions (million metric tons/year), MMBTU			Total Build Emissions (million metric tons/year), MMBTU			Changes in Emissions (million metric tons/year), MMBTU		
		Energy Use	Energy Use	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Energy - eGRID	Los Angeles to Anaheim			N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.0	47,044.2
	Statewide			N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.5	1,568,139.3

Totals	Total No Build Emissions			Total Build Emissions			Changes in Emissions		
	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Regional	27.9	28.4	454,414,325.5	27.3	27.7	444,776,544.1	-0.6	-0.6	-9,590,737.2
Statewide	44.6	45.2	722,177,540.5	43.2	43.8	701,327,793.1	-1.0	-1.0	-19,281,608.1

Criteria Report Tables

Source	County	No Project	Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)								Changes in Build Emissions (short tons/year)								
		Annual VMT	Annual VMT	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Roadway	LOS ANGELES	86,055,909,405	85,124,593,011	336	489	29,217	2,084	161	3,844	9,176	1,553	2,353	332	484	28,901	2,061	159	3,802	9,077	1,536	2,327	-4	-5	-316	-23	-2	-42	-99	-17	-25
	ORANGE	27,531,689,116	27,346,381,133	104	151	9,020	664	51	1,229	2,936	496	752	103	150	8,959	660	51	1,221	2,916	493	747	-1	-1	-61	-4	0	-8	-20	-3	-5
	SAN BERNARDINO	18,495,252,023	18,411,900,811	69	100	5,915	446	35	825	1,965	333	504	68	100	5,889	444	34	822	1,956	331	502	0	0	-27	-2	0	-4	-9	-2	-2
	RIVERSIDE	28,519,428,527	28,409,565,036	106	155	9,230	688	53	1,425	3,192	575	840	106	154	9,195	685	53	1,420	3,180	573	837	0	-1	-36	-3	0	-5	-12	-2	-3
	SAN DIEGO	5,386,124,914	5,248,119,114	19	28	1,532	129	10	240	572	97	147	19	28	1,493	125	10	234	557	94	143	0	-1	-39	-3	0	-6	-15	-2	-4
	IMPERIAL	1,033,072,252	1,028,651,701	4	5	299	25	2	46	111	19	28	4	5	298	25	2	46	111	19	28	0	0	-1	0	0	0	0	0	0
	SANTA BARBARA	1,038,912,666	1,005,143,024	4	5	290	25	2	52	116	21	31	4	5	281	24	2	50	112	20	30	0	0	-9	-1	0	-2	-4	-1	-1
	Regional Total	168,060,388,904	166,574,353,829	641	934	55,505	4,060	314	7,662	18,068	3,093	4,655	636	926	55,016	4,024	312	7,595	17,909	3,066	4,614	-6	-8	-489	-36	-3	-67	-159	-27	-41
	Statewide Total	261,252,464,970	256,484,063,423	996	1,451	86,627	6,312	489	11,665	27,540	4,709	7,091	990	1,441	86,063	6,204	480	11,454	27,040	4,626	6,964	-7	-10	-564	-109	-9	-210	-500	-83	-127

Source	Area	No Project	Full Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)								Changes in Build Emissions (short tons/year)								
		# of Flights	# of Flights	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Planes	Southern California	149,961	101,962	187	189	1,565	1,541	167	47	47	46	46	127	128	1,064	1,048	114	32	32	32	32	-60	-60	-501	-493	-53	-15	-15	-15	-15
	Statewide	380,189	268,814	474	479	3,968	3,908	423	118	118	118	118	335	338	2,805	2,763	299	84	84	83	83	-139	-140	-1162	-1145	-124	-35	-35	-35	-35

Source	Area	No Project	Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)								Changes in Build Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Energy	Los Angeles to Anaheim			321	1,784	2,847	2,317	115	320	320	317	317	321	1,788	2,853	2,320	115	320	320	318	318	0.4	3.7	6.2	3.2	0.5	0.7	0.7	0.6	0.6
	Statewide			2,205	20,757	45,146	20,858	3,177	3,921	3,921	3,564	3,564	2,217	20,881	45,353	20,963	3,194	3,944	3,944	3,585	3,585	12.4	124.5	206.6	105.5	16.9	22.8	22.8	20.9	20.9

Total	Area	No Project	Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)								Changes in Build Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
	Regional			1,149	2,907	59,916	7,918	596	8,028	18,435	3,457	5,018	1,084	2,842	58,933	7,392	540	7,947	18,261	3,416	4,963	-65	-65	-984	-526	-56	-81	-173	-41	-55
	Statewide			3,675	22,686	135,741	31,077	4,089	15,704	31,580	8,391	10,773	3,542	22,661	134,221	29,929	3,973	15,482	31,068	8,294	10,632	-133	-25	-1520	-1148	-116	-222	-512	-97	-141

** With entrained roadway dust*

Segment Los Angeles to Anaheim | Input Year: 2015 | Input Energy Type: eGRID | Scenario: High Scenario

GHG&Energy Report Tables Project Build year base: 2033

Source	County	Existing	EX+Project	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes Emissions (million metric tons/year), MMBTU		
		Annual VMT	Annual VMT	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Roadway	LOS ANGELES	73,236,845,700	72,310,888,632	23.5	23.9	347,205,425.0	23.2	23.6	342,815,594.8	-0.3	-0.3	-4,389,830.2
	ORANGE	23,786,461,969	23,598,774,570	7.4	7.5	109,524,528.5	7.4	7.5	108,660,323.8	-0.1	-0.1	-864,204.8
	SAN BERNARDINO	12,686,260,346	12,601,481,161	3.8	3.9	56,294,131.2	3.8	3.8	55,917,931.3	0.0	0.0	-376,200.0
	RIVERSIDE	17,638,349,903	17,527,712,591	5.3	5.4	78,850,040.8	5.3	5.4	78,355,450.6	0.0	0.0	-494,590.3
	SAN DIEGO	3,962,036,366	3,819,567,532	1.2	1.2	17,933,890.4	1.2	1.2	17,289,014.8	0.0	0.0	-644,875.6
	IMPERIAL	607,860,730	603,091,242	0.2	0.2	2,657,961.0	0.2	0.2	2,637,105.7	0.0	0.0	-20,855.3
	SANTA BARBARA	849,400,023	814,378,660	0.3	0.3	3,844,751.9	0.2	0.3	3,686,230.1	0.0	0.0	-158,521.8
	Regional Total	132,767,215,038	131,275,894,388	42	42	616,310,729	41	42	609,361,651	-0.5	-0.5	-6,949,077.9
	Statewide Total	203,997,417,634	199,280,213,986	62.7	63.7	925,394,823.2	61.3	62.2	903,996,141.4	-1.4	-1.5	-21,398,681.8

Source	Area	Existing	EX+Project	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes Emissions (million metric tons/year), MMBTU		
		# of Flights	# of Flights	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Planes	Southern California	100,674	68,130	0.872	0.9	12,078,343	0.590	0.595	8,173,881.835	-0.3	-0.3	-3,904,460.8
	Statewide	250,276	173,177	2.2	2.2	30,026,781	1.500	1.513	20,776,778.388	-0.7	-0.7	-9,250,003.0

Source	Area	Existing	EX+Project	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes in Emissions (million metric tons/year), MMBTU		
		Energy Use	Energy Use	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Energy - eGRID	Los Angeles to Anaheim			N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.0	51,748.6
	Statewide			N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.5	1,724,953.2

Totals	Total Existing Emissions (million metric tons/year), MMBTU			Total Existing Plus Project Emissions (million metric tons/year), MMBTU			Changes in Emissions (million metric tons/year), MMBtu		
	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Regional	42.6	43.3	628,389,071.5	41.9	42.5	617,535,532.9	-0.7	-0.8	-10,801,790.1
Statewide	64.9	65.8	955,421,604.6	62.8	63.7	924,772,919.8	-1.6	-1.6	-28,923,731.6

Criteria Report Tables

Source	County	Existing	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		Annual VMT	Annual VMT	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Roadway	LOS ANGELES	73,236,845,700	72,310,888,632.14	2,948	3,984	118,827	11,943	292	3,754	8,291	1,571	2,252	2,911	3,934	117,325	11,792	288	3,706	8,187	1,551	2,223	-37	-50	-1502	-151	-4	-47	-105	-20	-28
	ORANGE	23,786,461,969	23,598,774,570	921	1,244	37,850	3,871	95	1,217	2,691	508	729	914	1,234	37,551	3,840	94	1,207	2,670	504	724	-7	-10	-299	-31	-1	-10	-21	-4	-6
	SAN BERNARDINO	12,686,260,346	12,601,481,161	467	631	19,464	2,075	51	647	1,429	269	387	464	626	19,334	2,061	50	643	1,419	267	384	-3	-4	-130	-14	0	-4	-10	-2	-3
	RIVERSIDE	17,638,349,903	17,527,712,591	656	886	27,304	2,879	70	900	1,993	375	539	652	880	27,133	2,861	70	895	1,981	373	535	-4	-6	-171	-18	0	-6	-13	-2	-3
	SAN DIEGO	3,962,036,366	3,819,567,532	146	196	5,587	685	16	203	447	84	120	141	189	5,386	660	15	195	431	81	116	-5	-7	-201	-25	-1	-7	-16	-3	-4
	IMPERIAL	607,860,730	603,091,242	22	29	893	102	2	31	69	13	19	22	29	886	101	2	31	69	13	18	0	0	-7	-1	0	0	-1	0	0
	SANTA BARBARA	849,400,023	814,378,660	31	42	1,198	147	3	43	96	18	26	30	40	1,148	141	3	42	92	17	25	-1	-2	-49	-6	0	-2	-4	-1	-1
	Regional Total	132,767,215,038	131,275,894,388	5,192	7,012	211,123	21,700	529	6,795	15,017	2,838	4,072	5,134	6,933	208,763	21,455	523	6,719	14,848	2,806	4,026	-58	-79	-2,360	-245	-6	-76	-169	-32	-46
	Statewide Total	203,997,417,634	199,280,213,986	7,746	10,454	321,414	33,161	812	10,466	22,862	4,347	6,207	7,567	10,212	313,982	32,394	793	10,224	22,334	4,246	6,063	-179	-242	-7432	-767	-19	-242	-529	-101	-144

Source	Area	No Project	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		# of Flights	# of Flights	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Planes	Southern California	100,674	68,130	127	128	1,083	1,042	112	31	31	31	31	86	87	733	705	76	21	21	21	21	-41	-41	-350	-337	-36	-10	-10	-10	-10
	Statewide	250,276	173,177	315	318	2,692	2,589	279	78	78	78	78	218	220	1,863	1,792	193	54	54	54	54	-97	-98	-829	-798	-86	-24	-24	-24	-24

Source	Area	No Project	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Energy	Los Angeles to Anaheim			328	1,808	2,890	2,312	120	325	325	322	322	328	1,812	2,897	2,315	120	326	326	323	323	0	4	7	3	1	1	1	1	1
	Statewide			1,646	16,458	29,616	15,531	2,303	2,953	2,953	2,683	2,683	1,660	16,595	29,843	15,647	2,322	2,978	2,978	2,706	2,706	14	137	227	116	19	25	25	23	23

Total	Area	No Project	EX + Project	Total Existing Emissions (short tons/year)									Total Existing Plus Project Emissions (short tons/year)									Changes in Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
	Regional			5,646	8,948	215,096	25,053	760	7,151	15,373	3,192	4,425	5,547	8,832	212,393	24,475	719	7,066	15,195	3,150	4,370	-99	-116	-2703	-578	-42	-86	-178	-41	-55
	Statewide			9,707	27,229	353,722	51,281	3,394	13,497	25,894	7,108	8,968	9,444	27,027	345,688	49,832	3,308	13,256	25,366	7,006	8,823	-262	-203	-8034	-1448	-86	-241	-528	-102	-145

** With entrained roadway dust*

Segment Los Angeles to Anaheim | Input Year: 2040 | Input Energy Type: eGRID | Scenario: High Scenario

GHG&Energy Report Tables

Source	County	No Project	Build	Total No Build Emissions (million metric tons/year), MMBTU			Total Build Emissions (million metric tons/year), MMBTU			Changes Emissions (million metric tons/year), MMBTU		
		Annual VMT	Annual VMT	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Roadway	LOS ANGELES	87,075,870,799	85,788,971,213	14.0	14.2	228,800,727.8	13.8	14.0	225,419,268.0	-0.2	-0.2	-3,381,459.9
	ORANGE	27,846,004,312	27,585,155,461	4.4	4.4	71,584,942.1	4.3	4.4	70,914,366.5	0.0	0.0	-670,575.6
	SAN BERNARDINO	18,770,247,920	18,652,421,401	2.9	3.0	47,894,557.2	2.9	2.9	47,593,908.6	0.0	0.0	-300,648.6
	RIVERSIDE	29,009,461,048	28,855,696,779	4.5	4.6	74,021,147.6	4.5	4.6	73,628,799.4	0.0	0.0	-392,348.1
	SAN DIEGO	5,879,331,119	5,681,327,248	0.9	1.0	15,416,762.3	0.9	0.9	14,897,557.2	0.0	0.0	-519,205.1
	IMPERIAL	1,060,172,197	1,053,543,539	0.2	0.2	2,761,094.0	0.2	0.2	2,743,830.4	0.0	0.0	-17,263.6
	SANTA BARBARA	1,117,778,105	1,069,105,246	0.2	0.2	2,950,946.2	0.2	0.2	2,822,449.3	0.0	0.0	-128,496.9
	Regional Total	170,758,865,500	168,686,220,887	27	27	443,430,177	27	27	438,020,179	0	0	-5,409,998
	Statewide Total	269,784,125,131	263,228,132,814	42.6	43.3	698,659,003.6	41.6	42.2	681,680,973.3	-1.0	-1.1	-16,978,030.3

Source	Area	No Project	Build	Total No Build Emissions (million metric tons/year), MMBTU			Total Build Emissions (million metric tons/year), MMBtu			Changes Emissions (million metric tons/year), MMBTU		
		# of Flights	# of Flights	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Planes	Southern California	162,667	117,437	1.409	1.4	19,515,859	1.017	1.0	14,089,420	-0.4	-0.4	-5,426,438.4
	Statewide	416,659	309,505	3.6	3.6	49,988,443	2.7	2.7	37,132,745	-0.9	-0.9	-12,855,698.6

Source	Area	No Project	Build	Total No Build Emissions (million metric tons/year), MMBTU			Total Build Emissions (million metric tons/year), MMBTU			Changes in Emissions (million metric tons/year), MMBTU		
		Energy Use	Energy Use	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Energy - eGRID	Los Angeles to Anaheim			N/A	N/A	N/A	N/A	N/A	N/A	0.0	0.0	51,748.6
	Statewide			N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.5	1,724,953.2

Totals	Total No Build Emissions			Total Build Emissions			Changes in Emissions		
	CO2	CO2e	Energy	CO2	CO2e	Energy	CO2	CO2e	Energy
Regional	28.5	28.9	462,946,036.0	27.8	28.2	452,109,599.9	-0.7	-0.7	-10,784,687.4
Statewide	46.3	46.9	748,647,446.8	44.3	44.9	718,813,717.9	-1.5	-1.5	-28,108,775.7

Criteria Report Tables

Source	County	No Project	Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)									Changes in Build Emissions (short tons/year)								
		Annual VMT	Annual VMT	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Roadway	LOS ANGELES	87,075,870,799	85,788,971,213	340	495	29,563	2,108	163	3,890	9,285	1,571	2,381	335	488	29,126	2,077	160	3,832	9,148	1,548	2,346	-5	-7	-437	-31	-2	-57	-137	-23	-35
	ORANGE	27,846,004,312	27,585,155,461	105	153	9,123	672	52	1,243	2,969	502	761	104	151	9,037	666	52	1,231	2,942	497	754	-1	-1	-85	-6	0	-12	-28	-5	-7
	SAN BERNARDINO	18,770,247,920	18,652,421,401	70	102	6,003	453	35	838	1,994	338	511	69	101	5,966	450	35	832	1,982	336	508	0	-1	-38	-3	0	-5	-13	-2	-3
	RIVERSIDE	29,009,461,048	28,855,696,779	108	157	9,278	700	54	1,294	3,092	522	792	107	156	9,229	696	54	1,288	3,076	519	788	-1	-1	-49	-4	0	-7	-16	-3	-4
	SAN DIEGO	5,879,331,119	5,681,327,248	21	31	1,673	141	11	262	624	106	160	20	30	1,616	136	11	253	603	102	155	-1	-1	-56	-5	0	-9	-21	-4	-5
	IMPERIAL	1,060,172,197	1,053,543,539	4	6	307	25	2	47	114	19	29	4	6	305	25	2	47	113	19	29	0	0	-2	0	0	0	-1	0	0
	SANTA BARBARA	1,117,778,105	1,069,105,246	4	6	312	27	2	56	125	23	33	4	6	299	25	2	53	119	22	31	0	0	-14	-1	0	-2	-5	-1	-1
	Regional Total	170,758,865,500	168,686,220,887	651	948	56,260	4,126	319	7,630	18,203	3,080	4,667	643	937	55,579	4,076	315	7,537	17,982	3,043	4,610	-8	-12	-681	-50	-4	-93	-221	-37	-57
	Statewide Total	269,784,125,131	263,228,132,814	1,029	1,498	89,456	6,518	505	12,045	28,439	4,863	7,323	1,004	1,462	87,282	6,360	492	11,753	27,748	4,745	7,145	-25	-36	-2174	-158	-12	-293	-691	-118	-178

Source	Area	No Project	Full Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)									Changes in Build Emissions (short tons/year)								
		# of Flights	# of Flights	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Planes	Southern California	162,667	117,437	203	205	1,698	1,672	181	51	51	50	50	147	148	1,226	1,207	131	36	36	36	36	-56	-57	-472	-465	-50	-14	-14	-14	-14
	Statewide	416,659	309,505	520	525	4,348	4,282	464	129	129	129	129	386	390	3,230	3,181	345	96	96	96	96	-134	-135	-1118	-1101	-119	-33	-33	-33	-33

Source	Area	No Project	Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)									Changes in Build Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10	PM2.5	PM2.5	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
Energy	Los Angeles to Anaheim			321	1,784	2,847	2,317	115	320	320	317	317	321	1,788	2,854	2,320	115	320	320	318	318	0.4	4.1	6.8	3.5	0.6	0.8	0.8	0.7	0.7
	Statewide			2,205	20,757	45,146	20,858	3,177	3,921	3,921	3,564	3,564	2,218	20,894	45,373	20,974	3,195	3,946	3,946	3,587	3,587	13.7	136.9	227.3	116.0	18.6	25.1	25.1	23.0	23.0

Total	Area	No Project	Build	Total No Build Emissions (short tons/year)									Total Build Emissions (short tons/year)									Changes in Build Emissions (short tons/year)								
		Energy Use	Energy Use	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*	ROG	TOG	CO	NOX	SO2	PM10	PM10*	PM2.5	PM2.5*
	Regional			1,175	2,937	60,804	8,114	615	8,000	18,574	3,448	5,034	1,111	2,873	59,658	7,603	561	7,894	18,339	3,397	4,964	-64	-64	-1146	-511	-54	-106	-234	-51	-70
	Statewide			3,753	22,779	138,950	31,658	4,145	16,096	32,490	8,556	11,016	3,608	22,745	135,886	30,515	4,032	15,795	31,791	8,428	10,828	-145	-34	-3065	-1144	-113	-301	-699	-128	-188

** With entrained roadway dust*