

Appendix F

Energy Modeling

Title 24 Building Energy Efficiency Standard CalEEMod Input Adjustments

Land Use Type	Factor	2013	2016	2019
Residential	Percent Improvement over previous standard	n/a	28%	7%
Commercial	Percent Improvement over previous standard	n/a	5%	0%

Title 24 References: (CEC 2015) "2016 Building Energy Efficiency Standards"
(CEC 2018) "2019 Building Energy Efficiency Standards"

https://www.calbo.org/sites/main/files/file-attachments/2015-06-10_adoption_hearing_presentation.pdf
https://www.energy.ca.gov/sites/default/files/2020-03/Title_24_2019_Building_Standards_FAQ_ada.pdf

CalEEMod Default (2013 Title 24)

	Title 24 electricity intensity (kWh/size)	Title 24 natural gas intensity (KBTU/size)
Apartments Low Rise	365.68	7,043.85
Apartments Mid Rise	332.81	5,484.45
General Light Industry	1.48	19.71
Health Club	1.48	19.71
Parking Lot	-	-
Research & Development	1.48	19.71
University/College (4Yr)	2.73	20.83

2019 Title 24

	Title 24 electricity intensity (kWh/size)	Title 24 natural gas intensity (KBTU/size)
Apartments Low Rise	244.86	4,716.56
Apartments Mid Rise	222.85	3,672.39
General Light Industry	1.41	18.72
Health Club	1.41	18.72
Parking Lot	-	-
Research & Development	1.41	18.72
University/College (4Yr)	2.59	19.79

Percent Reduction

	Title 24 electricity intensity (kWh/size)	Title 24 natural gas intensity (KBTU/size)
Apartments Low Rise	33%	33%
Apartments Mid Rise	33%	33%
General Light Industry	5%	5%
Health Club	5%	5%
Parking Lot	-	-
Research & Development	5%	5%
University/College (4Yr)	5%	5%

<u>1999 Benchmarks</u>	<u>kWh/gsf/yr</u>	<u>therms/gsf/yr</u>
Academic/Administrative		
Non-complex Space	11.1	0.23
Housing Non-complex	7.8	0.32
Lab/Complex Space	36	1.85

		2019 Title 24 Adjusted CalEEMod Results					UCOP Performance Target: 60% below 1999 Benchmark				
Land Use	CalEEMod Land Use	gsf	kWh/yr	kWh/gsf/yr	therms/yr	therms/gsf/yr	kWh/yr (calculated from kWh/gsf/year)	kWh/gsf/yr	therms/yr (calculated from therms/gsf/year)	therms/gsf/yr	
Faculty Housing	Apts Low Rise	676,923	1,860,310.00	2.75	38,114.48	0.06	2,112,000	3.12	86,646.15	0.13	
Student Housing	Apts Mid Rise	1,933,846	5,051,120.00	2.61	95,757.76	0.05	6,033,600	3.12	247,532.31	0.13	
Facilities and Operations	General Light Industry	89,082	474,226.00	5.32	15,673.75	0.18	395,522	4.44	8,195.50	0.09	
Student Support Svcs	Health Club	935,554	4,980,420.00	5.32	164,609.34	0.18	4,153,859	4.44	86,070.95	0.09	
Parking Lot[1]	Parking Lot	1,876,275	656,696.00	0.35	0.00	0.00	656,696	0.35	0.00	0.00	
Instruction & Research	Research & Development	1,734,420	9,233,180.00	5.32	305,167.94	0.18	24,975,648	14.40	1,283,470.80	0.74	
Academic & Admin Support	University College (4 yr)	1,985,289	10,026,700.00	5.05	308,650.02	0.16	8,814,684	4.44	182,646.61	0.09	
Total:			4,582,741	3.50	927,973	0.10	47,142,010	5.11	1,894,562	0.21	

[1] Benchmark not used. No benchmarks were available for parking lot land uses. Factor used from CalEEMod.

Operational Energy Summary at Buildout (CalEEMod Energy outputs)

Electricity Detail - Annual

	Electricity Use
Land Use	kWh/yr
Apts Low Rise	1,860,310
Apts Mid Rise	5,051,120
General Light Industry	474,226
Health Club	4,980,420
Parking Lot	656,696
Research & Development	9,233,180
University College (4 yr)	10,026,700
Total	32,282,652

Natural Gas Detail - Annual

	NaturalGas Use	
Land Use	kBTU/yr	Therms/year (calculated)
Apts Low Rise	3,463,490	34,643
Apts Mid Rise	8,582,030	85,841
General Light Industry	1,470,160	14,705
Health Club	15,439,900	154,436
Parking Lot	-	-
Research & Development	28,624,000	286,308
University College (4 yr)	29,796,200	298,033
Total	87,375,780	873,967

Construction Fuel Usage

<https://www.theclimateregistry.org/wp-content/uploads/2020/04/The-Climate-Registry-2020-Default-Emission-Factor-Document.pdf>

Diesel Emission Factor 10.21 kg CO2/gallon
 Gasoline Emission Factor 8.78 kg CO2/gallon

off-road/on-road	Model	Fuel	Annual MT-CO2	gallons
off-road	CalEEMod (Building Construction)	Diesel	946.45	92,698
on-road	CalEEMod (Building Construction)	Gasoline	135.94	15,483 (worker commute only)
off-road	CalEEMod (Trails)	Diesel	4.68	458
on-road	CalEEMod (Trails)	Gasoline	0.19	21 (worker commute only)
off-road	RCEM (Bridges)	Diesel	493.86	48,370
on-road	RCEM (Bridges)	Gasoline	28.80	3,281 (worker commute only)
off-road	RCEM (Roadways)	Diesel	312.20	30,578
on-road	RCEM (Roadways)	Gasoline	25.15	2,864 (worker commute only)
Total				
			Diesel	1,757 172,105
			Gasoline	190 21,649

On-Road Fuel Usage Calculations

CalEEMod Fleet Mix

	Land Use	LDA	LDT1	LDT2	MDV	LHD1	LHD2	MHD	HHD	OBUS	UBUS	MCY	SBUS	MH
Faculty Housing	Apartments Low Rise	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515
Student Housing	Apartments Mis Rise	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515
Facilities and Operations	General Light Ind	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515
Student Support Svcs	Health Club	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515
Parking Lot1	Parking Lots	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515
Instruction & Research	Research & Develo	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515
Academic & Admin Support	University/College (4 yr)	0.607849	0.022927	0.205901	0.103922	0.009867	0.003828	0.022612	0.014637	0.001269	0.001293	0.00454	0.00084	0.000515

Annual VMT Attributed to LRDP

40,511,214

Annual VMT (Distributed)	Fleet Comp	EMFAC 2017 Factors for Santa Cruz County in 2040								Calculated			
		Region	Calendar Yr	Cat	Fuel	Population	VMT	Trips	Fuel Consumption	gal/mile	Gal Gas	Gal Diesel	NG DEG
1,006	0.014637	Santa Cruz	2040	HHDT	Gasoline	8,103,334	31,787,363,58	5301,703,704	5,704,833,523	0.179468596	180.47		
584,056	0.014637	Santa Cruz	2040	HHDT	Diesel	675,562,918	18,462,720,86	1803,096,378	2,259,108,173	0.122360523		71,465	
7,902	0.014637	Santa Cruz	2040	HHDT	Natural Gas	19,633,900	2,497,772,666	238,905,292	84,406,979,21	0.337928989			2,670
22,779,942	0.607849	Santa Cruz	2040	LDA	Gasoline	11,396,791,655	11,890,660,27	182,672,978.7	282,989,422,24	0.023799303	542,147		
288,263	0.607849	Santa Cruz	2040	LDA	Diesel	1,460,019,106	15,046,733,96	232,836,483	238,467,196,2	0.015848436		4,569	
1,556,496	0.607849	Santa Cruz	2040	LDA	Electricity	7,007,354,319	81,245,872,54	114,189,703.7	0	0			
895,260	0.022927	Santa Cruz	2040	LDT1	Gasoline	11,983,261,254	12,187,337,86	186,468,81.14	3425,707,488	0.028108743	25,165		
130	0.022927	Santa Cruz	2040	LDT1	Diesel	1,879,351	17,708,2125	2805,813,748	0.560648715	0.031660379		4	
33,410	0.022927	Santa Cruz	2040	LDT1	Electricity	395,009,717	45,481,681,139	64,192,3291	0	0			
8,013,215	0.205901	Santa Cruz	2040	LDT2	Gasoline	38,959,234,277	40,348,416,76	610,183,403.8	11,305,997,93	0.028020921	224,538		
81,724	0.205901	Santa Cruz	2040	LDT2	Diesel	384,012,399	41,149,87.62	61,213,4,2047	86,797,930,81	0.021093121		1,724	
246,361	0.205901	Santa Cruz	2040	LDT2	Electricity	1,551,815,624	12,404,843,76	25,255,833,538	0	0			
212,538	0.009867	Santa Cruz	2040	LHDT1	Gasoline	216,892,368,9	21,338,306.15	105,665,90.12	211,689,054,6	0.099206119	21,085		
187,186	0.009867	Santa Cruz	2040	LHDT1	Diesel	1,851,172,717	18,793,055,69	761,433,648	840,663,549,9	0.04473267		8,373	
41,983	0.00383	Santa Cruz	2040	LHDT2	Gasoline	270,673,202	2,772,851.86	131,866,91.62	312,035,548,2	0.112532354	4,724		
113,094	0.00383	Santa Cruz	2040	LHDT2	Diesel	767,477,883	7,469,452,576	315,682,7,355	379,387,539,3	0.05079188		5,744	
183,921	0.00454	Santa Cruz	2040	MCY	Gasoline	5,633,564,823	10,043,553,01	390,969,3,987	283,797,306,9	0.028256664	5,197		
3,928,456	0.103922	Santa Cruz	2040	MDV	Gasoline	24,178,721,757	24,567,129,3	376,732,63,79	840,139,60,78	0.034197712	134,344		
140,780	0.103922	Santa Cruz	2040	MDV	Diesel	839,234,626	8,803,886,018	133,255,1,544	240,342,42,54	0.027299584		3,843	
140,770	0.103922	Santa Cruz	2040	MDV	Electricity	1,087,491,652	8,803,219,102	1,777,679,044	0	0			
13,874	0.000515	Santa Cruz	2040	MH	Gasoline	300,928,377	8,830,76,838	984,4,294,07	149,441,893,2	0.169228641	2,348		
6,989	0.000515	Santa Cruz	2040	MH	Diesel	184,259,395	44,488,315,7	6025,282,215	39,022,833,18	0.087721661		613	
91,973	0.022612	Santa Cruz	2040	MHDT	Gasoline	216,359,211	34,459,13,501	141,555,5,237	576,821,778,4	0.167392994	15,396		
824,067	0.022612	Santa Cruz	2040	MHDT	Diesel	1,775,779,938	30,874,981,4	5,802,735,46	25,389,215,93	0.082232328		67,765	
28,931	0.001269	Santa Cruz	2040	OBUS	Gasoline	60,345,722	74,576,1,622,2	39,481,8,885,4	127,463,42,232	0.170917113	4,945		
22,477	0.001269	Santa Cruz	2040	OBUS	Diesel	36,218,967	57,940,2,591	101,948,48,94	65,367,65,748	0.112819063		2,536	
7,977	0.00084	Santa Cruz	2040	SBUS	Gasoline	31,972,143	46,218,4,172,7	41,819,56,356	40,924,55,738	0.088545995	706		
26,053	0.00084	Santa Cruz	2040	SBUS	Diesel	146,889,424	15,095,60,309	55,429,2,334,6	153,591,87,54	0.101746101		2,651	
808	0.001293	Santa Cruz	2040	UBUS	Gasoline	8,139,145	81,578,60,705	10,646,00,196	16,558,663,16	0.202978008	164		
18,754	0.001293	Santa Cruz	2040	UBUS	Diesel	54,754,250	18,925,96,457	71,618,55,861	264,278,70,58	0.13963817		2,619	
32,819	0.001293	Santa Cruz	2040	UBUS	Natural Gas	95,819,937	33,120,43,8	12,533,2,477,6	791,25,19,742	0.238901422			7,840

Total VMT

40,511,214

Total: 216,115.2
Electric: 4.65%

all others passenger 939,553 18,558 7,840
LHDT1, LHDT2 2-axle 25,810 14,118 -
MHDT, HHDT 3-axle 15,576 139,230 2,670
TOTAL: 980,939 171,906 10,511

eVMT
Electric kWh

1,977,036
632,651.60

Nat Gas Nat Gas
Gasoline (gal) Diesel (gal) (DEG) (therms)
980,939 171,906 10,511 14,600

EV kWh/mi
DEG = Diesel equivalent gallons
0.32 https://afdc.energy.gov/vehicles/electric_emissions_sources.html