

Calculation of 2021 Crude Average Carbon Intensity Value

Posting: Each year, pursuant to section 95489(b)(3) of the Low Carbon Fuel Standard (LCFS) Regulation,¹ CARB posts the Annual Crude Average carbon intensity calculation at the CARB-LCFS website for public comment. Written comments shall be accepted for 15 calendar days following the date on which the analysis was posted. Only comments related to potential factual or methodological errors in the posted Annual Crude Average carbon intensity value may be considered. CARB will evaluate the comments received and may request in writing additional information or clarification from the commenters. Commenters shall have 10 days to respond to these requests. No comments were submitted during the public comment period, and CARB is posting the final Annual Crude Average carbon intensity value.

Calculation of 2019, 2020, and 2021 Annual Crude Average Carbon Intensity Values: Table 1 below shows California crude volumes and Annual Crude Average carbon intensity values for 2019, 2020, and 2021.² Table 2 shows the breakdown of the sources of crude oil supplied to California refineries during 2021 as well as the carbon intensity values assigned to these crude sources.³ All crude oil produced in and offshore of California during 2021 was assumed to be refined in California. The volume contributions for California produced crudes are based on oil production data obtained from the California Department of Conservation.⁴ The volume contributions for California federal offshore crudes are based on oil production data obtained from the Bureau of Safety and Environmental Enforcement.⁵ The volume contributions of imported crudes are based on oil supply data submitted by refineries as part of annual LCFS reporting. The annual crude average carbon intensity values are a volume-weighted average of the carbon intensities for the crudes supplied in a given year.

Table 1. Crude Volumes and Annual Crude Average Carbon Intensity Values

Year	2019	2020	2021
CI (gCO ₂ e/MJ)	12.52	13.39	12.80
Volume (bbl)	584,313,143	478,388,940	518,262,620

¹ The LCFS regulation is published at California Code of Regulations (CCR), title 17, sections 95480-95503. Subsequent section references are to CCR title 17.

² Carbon intensity values and volumes for 2019 and 2020 are from [Calculation of 2019 Crude Average Carbon Intensity Value](#) and [2020 Annual Crude CI final \(ca.gov\)](#), respectively.

³ Crude carbon intensity values are from Table 9 of the LCFS regulation [Low Carbon Fuels Standard](#). These carbon intensity values are based on oil field data from the year 2015.

⁴ California Department of Conservation, [WellSTAR Data Dashboard \(ca.gov\)](#) (accessed October 25, 2022).

⁵ Bureau of Safety and Environmental Enforcement website [BSEE Pacific Production](#) (accessed June 15, 2022).

Calculation of California Baseline Crude Average Carbon Intensity:

$CI_{BaselineCrudeAve}$ is the California Baseline Crude Average carbon intensity value, in gCO₂e/MJ, attributed to the production and transport of the crude oil supplied as petroleum feedstock to California refineries during the baseline calendar year, 2010, and is calculated by the following formula for the 2021 compliance period:

$$CI_{BaselineCrudeAve} = 11.78$$

Calculation of Three-Year California Crude Average Carbon Intensity:

$CI_{2020CrudeAve}$ is the Three-year California Crude Average carbon intensity value, in gCO₂e/MJ, attributed to the production and transport of the crude oil supplied as petroleum feedstock to California refineries during the most recent three calendar years (2019, 2020 and 2021), and is calculated by the following formula:

$$CI_{2021CrudeAve} = \frac{[12.52 \times 584,313,143 + 13.39 \times 478,388,940 + 12.80 \times 518,262,620]}{[584,313,143 + 478,388,940 + 518,262,620]}$$

$$CI_{2021CrudeAve} = 12.88$$

Summary: The Three-year California Crude Average carbon intensity of 12.88 gCO₂e/MJ is greater than the California Baseline Crude Average carbon intensity of 11.78 gCO₂e/MJ plus 0.10 gCO₂e/MJ. Therefore, pursuant to sections 95489(a) and (b) of the LCFS regulation, incremental deficits of $1.10 \times E^{XD} \times C$ for CARBOB or diesel will be added to each affected regulated party's compliance obligation for the annual compliance period of 2023, where E^{XD} is the amount of fuel energy, in MJ, from CARBOB or diesel, as defined in section 95489(a), and

$$C = 1.0 \times 10^{-6} \frac{MT}{g CO_2 e}$$

Table 2. 2021 Refinery Crude Supply

Country/State	Crude Name	CI (g/MJ)	2021 Volume (bbl)
	<i>Annual Crude Average CI</i>	12.80	
Angola	Cabinda	8.99	1,860,493
	Clov	7.31	1,272
	Girassol	9.95	1,026,719
	Pazflor	8.02	789,370
Argentina	Medanito	10.78	5,710,457
Brazil	Atapu	11.78	1,757,951
	Buzios	11.78	1,036,291
	Frade	5.63	2,098,693
	Iracema (Cernambi)	5.54	962,069
	Lapa	11.78	1,435,533
	Lula (Tupi)	6.24	12,034,940
	Polvo	4.31	2,086,105
	Sapinhoa	6.00	12,805,513
	Tubarao Azul	5.45	393,574
Canada	Access Western Blend	15.15	195,505
	Albian Heavy Synthetic (all grades)	23.68	1,032,585
	Bow River	11.78	59,977
	Cold Lake	17.87	2,213,834
	Herbon	11.78	708,434
	Hibernia	11.78	2,033,597
	Kearl Lake	12.89	808,161
	Suncor Synthetic (all grades)	27.09	804,568
	Synthetic Sweet Blend	29.36	287,184
	Western Canadian Select	19.04	874,762
Colombia	Chaza	11.78	1,800,667
	South Blend	9.25	2,075,947
	Vasconia	9.62	13,210,887
Ecuador	Napo	8.31	13,580,710
	Oriente	10.07	38,333,829
Ghana	Jubilee	11.78	3,864,141
	Ten Blend	8.08	4,556,282
Guyana	Liza	11.78	23,976,312
Iraq	Basra Light	13.45	24,201,309
	Basra Heavy	10.69	2,128,502
	Basra Medium	11.78	19,188,969
Libya	Es Sider	11.78	2,093,934
	Zueitina	11.78	887,293
Mexico	Maya	7.85	9,176,910
	Isthmus	11.31	2,399,881

Country/State	Crude Name	CI (g/MJ)	2021 Volume (bb)
Neutral Zone (Saudi-Kuwait)	Eocene	7.85	398,068
	Ratawi	9.42	1,656,497
Nigeria	Agbami	12.04	962,179
	Bonga	5.06	1,443,770
	Forcados	8.97	1,953,065
	Yoho	11.45	949,444
Peru	Bretana	11.78	308,518
	Pirana	8.43	459,313
	Talara	11.78	657,596
Russia	CPC	11.78	689,262
	ESPO	11.55	8,280,710
	M100	17.35	729,805
	Sokol	6.94	5,095,818
Saudi Arabia	Arab Extra Light	9.41	3,914,547
	Arab Light	9.23	26,878,208
	Arab Medium	8.72	16,951,253
Trinidad	Molo	11.78	915,670
UAE	Murban	10.01	3,628,406
US Alaska	ANS	15.91	86,027,125
US New Mexico	Four Corners	11.11	359,774
US North Dakota	Bakken	9.73	696,457
US California	Aliso Canyon	4.94	88,882
	Ant Hill	20.81	13,792
	Antelope Hills	2.84	65,938
	Antelope Hills, North	24.75	121,453
	Arroyo Grande	31.11	485,623
	Asphalto	8.01	179,357
	Bandini	3.09	8,608
	Bardsdale	3.47	89,168
	Barham Ranch	4.15	42,523
	Beer Nose	3.98	10,031
	Belgian Anticline	5.01	28,061
	Bellevue	5.95	30,747
	Bellevue, West	6.60	23,860
	Belmont, Offshore	5.12	502,943
	Belridge, North	4.11	1,438,466
	Belridge, South	17.09	16,810,097
	Beverly Hills	5.41	312,651
Big Mountain	4.65	1,463	
Blackwells Corner	3.07	9,587	
Brea-Olinda	3.59	950,786	

Country/State	Crude Name	CI (g/MJ)	2021 Volume (bb)
	Brentwood	11.78	36,414
	Buena Vista	7.44	814,620
	Burrel	29.43	15,935
	Cabrillo	4.14	9,346
	Cal Canal Gas	11.78	18,986
	Canal	4.40	4,777
	Canfield Ranch	4.53	62,145
	Carneros Creek	4.06	2,022
	Cascade	3.00	77,212
	Casmalia	10.26	52,370
	Castaic Hills	2.68	8,824
	Cat Canyon	7.83	1,607,734
	Cheviot Hills	3.49	30,525
	Chico-Martinez	48.13	12,107
	Cienaga Canyon	5.78	9,344
	Coalinga	25.81	4,922,159
	Coles Levee, N	4.09	90,210
	Coles Levee, S	5.87	38,162
	Comanche	5.03	10,543
	Coyote, East	5.96	68,263
	Cuyama, South	14.70	143,248
	Cymric	15.69	12,093,104
	Deer Creek	11.51	29,223
	Del Valle	5.78	18,589
	Devils Den	7.51	8,509
	Dominguez	3.57	1,104
	Edison	14.53	511,823
	El Segundo	4.38	16,043
	Elk Hills	8.02	6,179,029
	Fruitvale	3.75	408,425
	Greeley	7.91	115,110
	Hasley Canyon	2.25	23,163
	Helm	3.99	16,868
	Holser	3.80	12,432
	Honor Rancho	3.43	15,360
	Huntington Beach	6.62	1,501,051
	Hyperion	1.90	10,878
	Inglewood	10.06	1,580,073
	Jacalitos	2.72	81,156
	Jasmin	16.59	103,882
	Kern Bluff	12.54	9,346
	Kern Front	35.68	2,550,861

Country/State	Crude Name	CI (g/MJ)	2021 Volume (bb)
	Kern River	15.09	14,974,081
	Kettleman Middle Dome	3.93	14,765
	Kettleman North Dome	3.42	113,303
	Landslide	12.53	4,793
	Las Cienegas	4.96	137,742
	Livermore	2.66	3,545
	Lompoc	28.45	236,887
	Long Beach	5.48	1,166,006
	Long Beach Airport	4.92	3,791
	Los Angeles Downtown	5.89	30,448
	Lost Hills	12.99	8,016,258
	Lost Hills, Northwest	5.36	9,966
	Lynch Canyon	23.10	52,863
	Mahala	4.99	5,076
	McDonald Anticline	4.33	30,019
	McKittrick	25.31	3,764,101
	Midway-Sunset	29.33	18,889,445
	Monroe Swell	11.78	10,634
	Montalvo, West	2.65	72,305
	Montebello	17.03	246,815
	Monument Junction	4.95	21,218
	Mount Poso	3.71	964,123
	Mountain View	3.97	65,430
	Newport, West	5.21	29,165
	Oak Canyon	4.04	15,111
	Oak Park	3.01	1,512
	Oakridge	3.46	71,457
	Oat Mountain	3.17	68,557
	Ojai	4.94	244,567
	Olive	1.82	34,180
	Orcutt	11.76	739,803
	Oxnard	5.39	91,608
	Paloma	4.88	11,618
	Placerita	32.78	310,278
	Playa Del Rey	6.87	45,240
	Pleito	2.09	325,788
	Poso Creek	21.96	3,780,659
	Pyramid Hills	3.36	43,342
	Railroad Gap	7.08	72,178
	Raisin City	9.13	59,413
	Ramona	4.47	23,812
	Richfield	4.75	172,865

Country/State	Crude Name	CI (g/MJ)	2021 Volume (bb)
	Rincon	4.88	116,903
	Rio Bravo	6.98	156,821
	Rio Viejo	2.74	88,717
	Riverdale	3.80	22,143
	Rose	2.91	135,354
	Rosecrans	5.76	81,060
	Rosecrans, South	3.54	12,126
	Rosedale	2.35	16,203
	Rosedale Ranch	8.32	77,771
	Round Mountain	24.04	2,333,284
	Russell Ranch	8.58	38,910
	Salt Lake	3.18	35,989
	Salt Lake, South	6.34	11,179
	San Ardo	26.42	5,885,169
	San Emidio Nose	11.78	8,516
	San Miguelito	5.25	254,884
	San Vicente	3.22	171,173
	Sansinena	3.21	189,132
	Santa Clara Avenue	3.53	12,306
	Santa Fe Springs	12.53	328,250
	Santa Maria Valley	4.80	67,018
	Sargent	4.00	15,759
	Saticoy	3.68	26,766
	Sawtelle	2.56	68,541
	Seal Beach	5.19	360,925
	Semitropic	4.30	21,947
	Sespe	3.98	285,699
	Shafter, North	3.32	308,934
	Shiells Canyon	5.07	31,710
	South Mountain	3.58	266,289
	Stockdale	2.18	85,453
	Tapia	6.92	8,445
	Tejon	13.77	61,682
	Tejon Hills	9.39	3,487
	Tejon, North	5.63	14,826
	Temescal	3.40	35,825
	Ten Section	7.50	44,638
	Timber Canyon	4.74	32,607
	Torrance	3.99	230,357
	Torrey Canyon	3.52	43,639
	Union Avenue	5.58	92,479
	Vallecitos	4.53	8,903

Country/State	Crude Name	CI (g/MJ)	2021 Volume (bbl)
	Ventura	4.54	3,203,022
	Wayside Canyon	2.36	7,426
	West Mountain	3.53	2,310
	Wheeler Ridge	2.80	39,162
	White Wolf	1.92	7,480
	Whittier	3.71	94,010
	Wilmington	8.31	11,556,364
	Yowlumne	13.90	137,086
	Zaca	9.53	173,733
US Federal OCS	Beta	1.59	1,241,765
	Carpinteria	3.28	127,023
	Dos Cuadras	4.57	962,386
	Hueneme	4.67	73,602
	Point Pedernales	8.26	1,230,365
	Santa Clara	2.46	356,652