

Calculation of 2018 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. CARB evaluated the comments received within the comment period, and is posting the final Annual Crude Average carbon intensity value.²

Calculation of 2016, 2017 and 2018 Annual Crude Average Carbon Intensity Values:

Table 1 below shows California crude volumes and Annual Crude Average carbon intensity values for 2016, 2017 and 2018.³ Table 2 shows the breakdown of the sources of crude oil supplied to California refineries during 2018 as well as the carbon intensity values assigned to these crude sources.⁴ All crude oil produced in and offshore of California during 2018 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.⁵ The volume contributions for California federal offshore crudes are based on oil production data obtained from the Bureau of Safety and Environmental Enforcement.⁶ 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 | 2016 | 2017 | 2018 |
|----------------------------|-------------|-------------|-------------|
| CI (gCO _{2e} /MJ) | 12.14 | 11.93 | 12.35 |
| Volume (bbl) | 582,101,235 | 621,246,732 | 624,127,435 |

Calculation of California Baseline Crude Average Carbon Intensity:

$CI_{BaselineCrudeAve}$ is the California Baseline Crude Average carbon intensity value, in gCO_{2e}/MJ, attributed to the production and transport of the crude oil supplied as

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 Comments and CARB responses are contained in the appendix to this document.

³ Carbon intensity values for 2016 and 2017 are from Table 9 of the LCFS regulation [Low Carbon Fuels Standard](#). Volumes for 2016 and 2017 are from Calculation of the 2017 Crude Average Carbon Intensity Value [Calculation of 2017 Crude Average Carbon Intensity Value](#)

⁴ 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.

⁵ California Department of Conservation, 2018 Report of California Oil and Gas Production Statistics. [2018 Annual Report of CA Oil and Gas Production](#).

⁶ Bureau of Safety and Environmental Enforcement website [BSEE Pacific Production](#) (accessed May 2, 2019).

petroleum feedstock to California refineries during the baseline calendar year, 2010, and is calculated by the following formula for the 2018 compliance period:

$$CI_{BaselineCrudeAve} = \frac{[11.98 \times 582,101,235 + 11.98 \times 621,246,732 + 11.78 \times 624,127,435]}{[582,101,235 + 621,246,732 + 624,127,435]}$$

$$CI_{BaselineCrudeAve} = 11.91$$

Calculation of Three-Year California Crude Average Carbon Intensity:

$CI_{2018CrudeAve}$ 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 (2016, 2017 and 2018), and is calculated by the following formula:

$$CI_{2018CrudeAve} = \frac{[12.14 \times 582,101,235 + 11.93 \times 621,246,732 + 12.35 \times 624,127,435]}{[582,101,235 + 621,246,732 + 624,127,435]}$$

$$CI_{2018CrudeAve} = 12.14$$

Summary: The Three-year California Crude Average carbon intensity of 12.14 gCO₂e/MJ is greater than the California Baseline Crude Average carbon intensity of 11.91 gCO₂e/MJ plus 0.10 gCO₂e/MJ. Therefore, pursuant to sections 95489(a) and (b) of the LCFS regulation, incremental deficits of $0.23 \times E^{XD} \times C$ for CARBOB or diesel will be added to each affected regulated party's compliance obligation for the annual compliance period of 2020, 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: 2018 Refinery Crude Supply

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|-------------------------------------|-------------------|--------------------------|
| | 2018 Volume Weighted Average CI | 12.35 | 624,127,435 |
| Angola | Clov | 7.31 | 15,622 |
| | Dalia | 8.90 | 2,522,982 |
| | Gimboa | 8.86 | 822,027 |
| | Girassol | 9.95 | 93,989 |
| | Greater Plutonio | 8.72 | 1,004,932 |
| | Nemba | 9.08 | 942,080 |
| | Pazflor | 8.02 | 4,821,795 |
| Argentina | Escalante | 10.15 | 1,772,197 |
| Australia | Pyrenees | 8.24 | 6,568 |
| Brazil | Atlanta | 11.78 | 658,824 |
| | Frade | 5.63 | 1,002,884 |
| | Iracema (Cernambi) | 5.54 | 6,031,213 |
| | Lula | 6.24 | 9,290,082 |
| | Mero | 11.78 | 502,121 |
| | Ostra | 5.65 | 3,070,178 |
| | Peregrino | 4.16 | 623,038 |
| | Sapinhua | 6.00 | 7,342,701 |
| | Tubarao Martelo | 5.37 | 727,064 |
| Brunei | Seria Light Export Blend | 11.78 | 194,914 |
| Canada | Access Western Blend | 15.15 | 1,776,677 |
| | Albian Heavy Synthetic (all grades) | 23.68 | 868,227 |
| | Burnaby Blend | 11.78 | 278,000 |
| | Christina Dilbit Blend | 12.71 | 327,314 |
| | Cold Lake | 17.87 | 4,875,687 |
| | Fort Hills | 11.78 | 681,348 |
| | Kearl Lake | 12.89 | 3,046,505 |
| | Mixed Sweet | 8.11 | 79,064 |
| | Peace River Sour | 8.11 | 3,250 |
| | Surmont Heavy Blend | 22.48 | 1,485,537 |
| | Syncrude Synthetic (all grades) | 31.62 | 371,605 |
| | Western Canadian Select | 19.04 | 182,451 |
| Colombia | Acordionero | 6.96 | 325,884 |
| | Castilla | 10.55 | 4,739,922 |
| | Chaza | 11.78 | 1,816,689 |
| | Puerto Bahia | 11.78 | 365,442 |
| | South Blend | 9.25 | 1,347,224 |
| | Vasconia | 9.62 | 37,540,768 |

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|-------------------------|-------------------|--------------------------|
| Ecuador | Napo | 8.31 | 21,851,807 |
| | Oriente | 10.07 | 31,593,153 |
| Equatorial Guinea | Zafiro | 20.56 | 3,850,536 |
| Ghana | Ten Blend | 8.08 | 3,155,969 |
| Iraq | Basra Light | 13.45 | 30,808,908 |
| Kuwait | Kuwait | 10.56 | 19,671,534 |
| Mexico | Maya | 7.85 | 18,504,160 |
| Nigeria | Antan | 21.98 | 2,117 |
| | Bonga | 5.06 | 1,870,925 |
| | Forcados | 8.97 | 1,928,189 |
| Oman | Oman | 13.32 | 112,128 |
| Peru | Pirana | 8.43 | 261,510 |
| Russia | CPC Blend | 11.78 | 1,299,450 |
| | ESPO | 11.55 | 792,718 |
| | Sokol | 6.94 | 3,504,791 |
| | Vityaz | 9.60 | 400,544 |
| Saudi Arabia | Arab Extra Light | 9.41 | 20,059,988 |
| | Arab Light | 9.23 | 87,299,942 |
| | Arab Medium | 8.72 | 21,004,457 |
| | Arab Heavy | 7.92 | 230,100 |
| Trinidad | Calypso | 7.41 | 99,550 |
| | Molo | 11.78 | 551,366 |
| UAE | Upper Zakum | 7.96 | 75,844 |
| UK | North Sea Kraken | 11.78 | 788,353 |
| Venezuela | Hamaca | 23.04 | 547,870 |
| | Hamaca DCO | 10.02 | 669,250 |
| | Santa Barbara | 17.32 | 2,170 |
| US Alaska | ANS | 15.91 | 83,471,217 |
| US New Mexico | Four Corners | 11.11 | 932,754 |
| US Texas | West Texas Intermediate | 11.93 | 467,041 |
| US Utah | Covenant | 4.43 | 52,139 |
| | Utah Sweet | 6.92 | 768,597 |
| US California* | Aliso Canyon | 4.94 | 51,171 |
| | Ant Hill | 20.81 | 21,154 |
| | Antelope Hills | 2.84 | 87,793 |
| | Antelope Hills, North | 24.75 | 245,887 |
| | Arroyo Grande | 31.11 | 533,059 |
| | Asphalto | 8.01 | 165,721 |
| | Bandini | 3.09 | 9,144 |

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|-------------------|-------------------|--------------------------|
| | Bardsdale | 3.47 | 149,900 |
| | Barham Ranch | 4.15 | 80,927 |
| | Beer Nose | 3.98 | 9,164 |
| | Belgian Anticline | 5.01 | 30,930 |
| | Bellevue | 5.95 | 24,666 |
| | Bellevue, West | 6.60 | 53,053 |
| | Belmont, Offshore | 5.12 | 449,731 |
| | Belridge, North | 4.11 | 1,762,905 |
| | Belridge, South | 17.09 | 20,915,436 |
| | Beverly Hills | 5.41 | 316,472 |
| | Big Mountain | 4.65 | 17,665 |
| | Blackwells Corner | 3.07 | 22,741 |
| | Brea-Olinda | 3.59 | 1,037,187 |
| | Brentwood | 11.78 | 22,474 |
| | Buena Vista | 7.44 | 1,298,257 |
| | Burrel | 29.43 | 7,389 |
| | Cabrillo | 4.14 | 18,414 |
| | Cal Canal Gas | 11.78 | 19,940 |
| | Canal | 4.40 | 14,404 |
| | Canfield Ranch | 4.53 | 65,430 |
| | Carneros Creek | 4.06 | 13,633 |
| | Cascade | 3.00 | 91,419 |
| | Casmalia | 10.26 | 122,251 |
| | Castaic Hills | 2.68 | 6,593 |
| | Cat Canyon | 7.83 | 1,434,234 |
| | Cheviot Hills | 3.49 | 37,892 |
| | Chico-Martinez | 48.13 | 33,369 |
| | Cienaga Canyon | 5.78 | 9,661 |
| | Coalinga | 25.81 | 6,340,065 |
| | Coles Levee, N | 4.09 | 83,841 |
| | Coles Levee, S | 5.87 | 51,479 |
| | Comanche | 5.03 | 13,445 |
| | Coyote, East | 5.96 | 172,882 |
| | Cuyama, South | 14.70 | 189,386 |
| | Cymric | 15.69 | 12,970,618 |
| | Deer Creek | 11.51 | 33,822 |
| | Del Valle | 5.78 | 29,471 |
| | Devils Den | 7.51 | 8,381 |
| | Dominguez | 3.57 | 22,334 |

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|-----------------------|-------------------|--------------------------|
| | Edison | 14.53 | 588,931 |
| | El Segundo | 4.38 | 20,524 |
| | Elk Hills | 8.02 | 8,574,673 |
| | Fruitvale | 3.75 | 387,402 |
| | Greeley | 7.91 | 148,442 |
| | Hasley Canyon | 2.25 | 27,790 |
| | Helm | 3.99 | 83,493 |
| | Holser | 3.80 | 14,162 |
| | Honor Rancho | 3.43 | 27,292 |
| | Huntington Beach | 6.62 | 1,906,809 |
| | Hyperion | 1.90 | 10,755 |
| | Inglewood | 10.06 | 1,977,358 |
| | Jacalitos | 2.72 | 89,640 |
| | Jasmin | 16.59 | 138,580 |
| | Kern Bluff | 12.54 | 35,641 |
| | Kern Front | 35.68 | 3,471,459 |
| | Kern River | 15.09 | 16,386,354 |
| | Kettleman Middle Dome | 3.93 | 16,740 |
| | Kettleman North Dome | 3.42 | 108,532 |
| | Landslide | 12.53 | 35,544 |
| | Las Cienegas | 4.96 | 173,097 |
| | Livermore | 2.66 | 4,918 |
| | Lompoc | 28.45 | 261,123 |
| | Long Beach | 5.48 | 1,265,165 |
| | Long Beach Airport | 4.92 | 7,660 |
| | Los Angeles Downtown | 5.89 | 41,778 |
| | Los Angeles, East | 14.71 | 182,283 |
| | Lost Hills | 12.99 | 9,658,387 |
| | Lost Hills, Northwest | 5.36 | 6,385 |
| | Lynch Canyon | 23.10 | 215,515 |
| | Mahala | 4.99 | 10,200 |
| | McCool Ranch | 9.59 | 8,624 |
| | McDonald Anticline | 4.33 | 49,495 |
| | McKittrick | 25.31 | 2,619,856 |
| | Midway-Sunset | 29.33 | 20,655,818 |
| | Montalvo, West | 2.65 | 280,077 |
| | Montebello | 17.03 | 394,874 |
| | Monument Junction | 4.95 | 81,423 |

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|-------------------|-------------------|--------------------------|
| | Mount Poso | 3.71 | 1,612,717 |
| | Mountain View | 3.97 | 78,434 |
| | Newhall-Potrero | 3.66 | 52,575 |
| | Newport, West | 5.21 | 76,706 |
| | Oak Canyon | 4.04 | 16,693 |
| | Oak Park | 3.01 | 9,969 |
| | Oakridge | 3.46 | 99,675 |
| | Oat Mountain | 3.17 | 54,744 |
| | Ojai | 4.94 | 245,226 |
| | Olive | 1.82 | 47,657 |
| | Orcutt | 11.76 | 891,061 |
| | Oxnard | 5.39 | 360,708 |
| | Paloma | 4.88 | 13,535 |
| | Placerita | 32.78 | 566,594 |
| | Playa Del Rey | 6.87 | 27,736 |
| | Pleito | 2.09 | 670,322 |
| | Poso Creek | 21.96 | 5,130,861 |
| | Pyramid Hills | 3.36 | 43,176 |
| | Railroad Gap | 7.08 | 113,586 |
| | Raisin City | 9.13 | 135,582 |
| | Ramona | 4.47 | 30,465 |
| | Richfield | 4.75 | 188,696 |
| | Rincon | 4.88 | 235,485 |
| | Rio Bravo | 6.98 | 206,396 |
| | Rio Viejo | 2.74 | 45,767 |
| | Riverdale | 3.8 | 68,126 |
| | Rose | 2.91 | 217,810 |
| | Rosecrans | 5.76 | 123,214 |
| | Rosecrans, South | 3.54 | 8,373 |
| | Rosedale | 2.35 | 13,053 |
| | Rosedale Ranch | 8.32 | 115,156 |
| | Round Mountain | 24.04 | 2,567,799 |
| | Russell Ranch | 8.58 | 46,965 |
| | Salt Lake | 3.18 | 19,627 |
| | Salt Lake, South | 6.34 | 3,696 |
| | San Ardo | 26.42 | 8,173,645 |
| | San Miguelito | 5.25 | 330,190 |
| | San Vicente | 3.22 | 139,819 |
| | Sansinena | 3.21 | 200,496 |

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|--------------------|-------------------|--------------------------|
| | Santa Clara Avenue | 3.53 | 32,746 |
| | Santa Fe Springs | 12.53 | 690,628 |
| | Santa Maria Valley | 4.80 | 80,452 |
| | Santa Susana | 5.29 | 7,167 |
| | Sargent | 4.00 | 19,281 |
| | Saticoy | 3.68 | 34,314 |
| | Sawtelle | 2.56 | 148,911 |
| | Seal Beach | 5.19 | 392,210 |
| | Semitropic | 4.30 | 24,908 |
| | Sespe | 3.98 | 335,009 |
| | Shafter, North | 3.32 | 450,403 |
| | Shiells Canyon | 5.07 | 50,589 |
| | South Mountain | 3.58 | 452,341 |
| | Stockdale | 2.18 | 100,108 |
| | Tapia | 6.92 | 10,651 |
| | Tapo Canyon, South | 3.08 | 7,563 |
| | Tejon | 13.77 | 222,511 |
| | Tejon Hills | 9.39 | 8,026 |
| | Tejon, North | 5.63 | 29,230 |
| | Temescal | 3.40 | 53,416 |
| | Ten Section | 7.50 | 64,685 |
| | Timber Canyon | 4.74 | 16,513 |
| | Torrance | 3.99 | 368,052 |
| | Torrey Canyon | 3.52 | 77,568 |
| | Union Avenue | 5.58 | 9,159 |
| | Vallecitos | 4.53 | 13,421 |
| | Ventura | 4.54 | 4,038,762 |
| | Wayside Canyon | 2.36 | 1,177 |
| | West Mountain | 3.53 | 12,718 |
| | Wheeler Ridge | 2.8 | 57,814 |
| | White Wolf | 1.92 | 11,423 |
| | Whittier | 3.71 | 80,406 |
| | Wilmington | 8.31 | 10,818,132 |
| | Yowlumne | 13.9 | 135,336 |
| | Zaca | 9.53 | 168,052 |
| US Federal OCS | Beta | 1.59 | 1,831,734 |
| | Carpinteria | 3.28 | 298,411 |
| | Dos Cuadras | 4.57 | 891,895 |
| | Hueneme | 4.67 | 56,873 |

| Country/State | Crude Name | CI (g/MJ)* | 2018 Volume (bbl) |
|----------------------|-------------------|-------------------|--------------------------|
| | Point Pedernales | 8.26 | 1,305,249 |
| | Santa Clara | 2.46 | 488,785 |

*CI values from Table 9 of the LCFS regulation are based on oil field operational data from the year 2015

Appendix: Responses to comments

Comment: see comment at

[Comment 6 for Comments on Crude Oil analysis for LCFS](#)

Response:

This comment is not related to the Annual Crude Average CI calculation.

Comment: see comment at

[Comment 7 for Comments on Crude Oil analysis for LCFS](#)

Response: The commenter suggests that emission reduction activities at California oil fields such as solar electricity projects should be accounted for in the calculation of the Annual Crude Average CI.

In calculating the Annual Crude Average CI, the LCFS regulation requires the use of CI values approved through a formal regulatory process. These CI values are listed in Table 9 of the regulation text. The crude CI values used to calculate the 2018 Crude Average CI were approved as part of the 2018 LCFS regulatory amendment process and are based on oil field production data from the year 2015. Staff is unaware of any solar electricity projects implemented at California oil fields at that time. Since 2016, staff is aware of two solar electricity projects that have been implemented at the Midway Sunset oil field. Greenhouse gas reductions from these projects will be accounted for in calculating updated CI values for Table 9 as part of the next LCFS amendment cycle.