APPENDIX H

ESTIMATING CARBON INTENSITY VALUES FOR THE CRUDE LOOKUP TABLE

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Appendix H. Estimating Carbon Intensity Values for the Crude Lookup Table

Proposed Crude Lookup Table CI Values for Individual Crudes

All carbon intensity values were calculated using the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Version 1.1 Draft D.[1] A description of the model is provided in the model user guide and technical documentation.[2] Versions of OPGEE have been presented for stakeholder review at five ARB workshops[3] and also reviewed and/or utilized as part of several reports and journal publications.[4,5,6,7,8,9,10] In estimating the carbon intensity for crude oil production and transport to the refinery, OPGEE uses, as model inputs, detailed field-level data such as production method and surface processing equipment, reservoir properties, crude oil and associated gas properties, production and injection volumes, and transport data such as modes of transport and distances from the field to the refinery. In those instances where this level of detail is not known, OPGEE fills in missing data with simple defaults and smart defaults. Smart defaults are used for lesser known parameters that can be correlated to frequently known parameters. Examples of smart defaults in OPGEE are the estimation of water-oil-ratio and gas-to-oil ratio using field age and crude density as correlation parameters and the estimation of flaring rate using location of crude production together with satellite data.

Detailed model inputs used to estimate the lookup table carbon intensity values shown in Table 1 are contained in an Excel file.[11] In order to duplicate these carbon intensity

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[1] El-Houjeiri, H.M., Vafi, K., Duffy, J., McNally, S., and A.R. Brandt, Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 1.1 Draft D, October 1, 2014.

[2] El-Houjeiri, H.M., Vafi, K., Duffy, J., McNally, S., and A.R. Brandt, Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 1.1 Draft D, User Guide and Technical Documentation, October 1, 2014.

[3] Workshops held on March 19, 2012; July 12, 2012; March 5, 2013; March 11, 2014; and July 10, 2014. Workshop materials can be accessed at http://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/lcfs_meetings.htm

[4] El-Houjeiri, H.M., Brandt, A.R., Duffy, J.E. (2013) Open source LCA tool for estimating greenhouse gas emissions from crude oil production using field characteristics. *Environmental Science & Technology*. DOI: 10.1021/es304570m

[5] El-Houjeiri, H.M., A.R. Brandt (2012). Exploring the variation of GHG emissions from conventional oil production using an engineering-based LCA model. American Center for Life Cycle Assessment (ACLCA) LCA XII Conference. Tacoma, WA, September 27th 2012.

[6] IHS Inc. (2014) *Comparing GHG intensity of the oil sands and the average US crude oil*. May 2014.

[7] ICCT (2014). *Upstream Emissions of Fossil Fuel Feedstocks for Transport Fuels Consumed in the European Union.* Authors: Chris Malins, Sebastian Galarza, Anil Baral, Adam Brandt, Hassan El-Houjeiri, Gary Howorth, Tim Grabiel, Drew Kodjak. Washington D.C.: The International Council on Clean Transportation (ICCT).

[8] O'Connor, D. (2013) OPGEE analysis and comparison to GHGenius. Prepared for Natural Resources Canada, August 19th, 2013.

[9] Vafi, K and A.R. Brandt (2014), Uncertainty of Oil Field GHG Emissions Resulting from Information Gaps: A Monte Carlo Approach, *Environmental Science and Technology*, 48, 10511-10518, dx.doi.org/10.1021/es502107s.

[10] Vafi, K and A.R. Brandt (2014), Reproducibility of LCA Models of Crude Oil Production, *Environmental Science and Technology*, Articles ASAP, dx.doi.org/10.1021/es501847p.

[11] MCON Inputs Spreadsheet for Crude Lookup Table, Spreadsheet titled "Lookup_Table_MCON_Inputs_OPGEE_v1.1.xlsx."

values, the OPGEE v1.1 bulk assessment tool must be used for all crudes except oil sands mining, for which the Bitumen Extraction and Mining sheet must be utilized. Model inputs for each crude source can be copied from the Excel file into the corresponding cells on the bulk assessment sheet and the Run Assessment button clicked. For a few crudes, additional cells not on the bulk assessment sheet must be modified from defaults. These changes are noted on the model inputs spreadsheets for these crudes.

Table 1: Carbon Intensity Lookup Table for Crude Oil Production and Transport

Country of Origin	Crude Identifier	Carbon Intensity Values (gCO2e/MJ)
Algeria	Saharan	11.69
Angola	Cabinda	10.03
	Dalia	9.78
	Gimboa	9.65
	Girassol	10.33
	Greater Plutonio	9.78
	Hungo	9.10
	Kissanje	9.65
	Mondo	9.80
	Nemba	10.19
	Pazflor	8.91
Argentina	Canadon Seco	9.28
	Escalante	9.30
	Hydra	8.08
	Medanito	9.98
Australia	Enfield	5.09
	Pyrenees	5.99
	Stybarrow	6.31
	Van Gogh	6.14
	Vincent	5.05
Azerbaijan	Azeri	8.25
Brazil	Albacora Leste	6.55
	Bijupira-Salema	8.08
	Frade	6.12
	Jubarte	8.37
	Lula	9.94
	Marlim	7.76
	Marlim Sul	8.49
	Ostra	6.54
	Polvo	6.39
	Roncador	7.44
	Roncador Heavy	7.09
	Sapinhoa	8.53
Cameroon	Lokele	22.29
Canada	Access Western Blend	17.21
	Albian Heavy Synthetic	20.52
	Albian Muskeg River Heavy	20.52
	BC Light	8.27
	Bonnie Glen	8.27
	Borealis Heavy Blend	18.32
	Bow River	9.27

	Cardium	8.27
	Christina Dilbit Blend	14.04
	Christina Synbit	17.90
	CNRL Light Sweet Synthetic	21.39
	Cold Lake	19.64
	Conventional Heavy	9.27
	Federated	8.27
	Fosterton	9.27
	Gibson Light Sweet	8.27
	Halkirk	8.27
	Hardisty Light	8.27
	Hardisty Synthetic	36.96
	Husky Synthetic	36.62
	Joarcam	8.27
	Kerrobert Sweet	8.27
	Koch Alberta	8.27
	Light Sour Blend	8.27
	Light Sweet	8.27
	Lloyd Blend	9.27
	Lloyd Kerrobert	9.27
	Lloydminster	9.27
	Long Lake Heavy	32.04
	Long Lake Light Synthetic	37.29
	Mackay Heavy Blend	20.76
	Medium Gibson Sour	8.27
	Medium Sour Blend	8.27
	Midale	8.27
	Mixed Sour blend	8.27
	Mixed Sweet	8.27
	Peace	8.27
	Peace Pipe Sour	8.27
	Peace River Heavy	22.03
	Peace River Sour	8.27
	Pembina	8.27
	Pembina Light Sour	8.27
	Premium Albian Synthetic	21.39
	Premium Conventional Heavy	9.27
	Premium Synthetic	21.39
	Rangeland Sweet	8.27
	Redwater	8.27
	Seal Heavy	9.27
	Shell Synthetic (all grades)	21.39
	Smiley-Coleville	9.27
	Sour High Edmonton	8.27
	Sour Light Edmonton	8.27

	Statoil Cheecham Dilbit	15.32
	Statoil Cheecham Synbit	18.75
	Suncor Synthetic (all grades)	24.16
	Surmont Heavy Blend	18.82
	Synbit Blend	21.65
	Syncrude Synthetic (all grades)	21.39
	Synthetic Sweet Blend	22.78
	Tundra Sweet	8.27
	Wabasca	6.79
	Western Canadian Blend	9.27
	Western Canadian Select	19.31
Chad	Doba	8.08
Colombia	Cano Limon	9.41
	Castilla	9.61
	Cusiana	10.67
	Magdalena	22.27
	Rubiales	9.20
	South Blend	9.22
	Vasconia	9.33
Congo	Azurite	11.49
	Djeno	11.87
Ecuador	Napo	9.56
	Oriente	10.90
Equatorial Guinea	Ceiba	10.88
	Zafiro	21.56
Iraq	Basra Light	13.08
Kuwait	Kuwait	10.31
Libya	Amna	13.98
Malaysia	Tapis	11.00
Mauritania	Chinquetti	9.28
Mexico	Isthmus	10.16
	Isthmus Topped	13.16
	Maya	7.97
Neutral Zone	Eocene	7.48
	Khafji	9.04
	Ratawi	9.42
Nigeria	Agbami	19.29
	Amenam	17.92
	Antan	33.44
	Bonga	6.44
	Bonny	15.53
	Brass	82.48
	EA	6.24
	Erha	10.50
	Escravos	20.52

	Forcados	22.41
	Okono	27.55
	OKWB	34.80
	Pennington	21.69
	Qua Iboe	15.25
	Yoho	15.25
Oman	Oman	12.72
Peru	Loreto	8.23
	Mayna	9.85
Russia	ESPO	13.70
	M100	19.18
	Sokol	10.51
	Vityaz	11.55
Saudi Arabia	Arab Extra Light	9.35
	Arab Light	9.15
	Arab Medium	8.66
	Arab Heavy	8.77
Thailand	Bualuang	5.12
Trinidad	Calypso	7.37
	Galeota	10.57
UAE	Murban	9.92
	Upper Zakum	8.97
Venezuela	Bachaquero	26.77
	Boscan	10.76
	Hamaca	23.51
	Hamaca DCO	7.63
	Laguna	26.77
	Mesa 30	11.45
	Petrozuata (all synthetic grades)	23.53
	Zuata (all synthetic grades)	23.51
US Alaska	Alaska North Slope	12.93
US Colorado	Niobrara	8.03
US New Mexico	Four Corners	9.37
	New Mexico Intermediate	9.37
	New Mexico Sour	9.37
	New Mexican Sweet	9.37
US North Dakota	Bakken	10.18
	North Dakota Sweet	10.18
	Williston Basin Sweet	10.18
US Oklahoma	Oklahoma Sour	12.03
	Oklahoma Sweet	12.03
US Texas	Eagle Ford Shale	12.03
	East Texas	12.03
	North Texas Sweet	12.03
	South Texas Sweet	12.03

	West Texas Intermediate	12.03
	West Texas Sour	12.03
US Utah	Covenant	3.78
	Utah Sweet	6.14
US Wyoming	Wyoming Sweet	24.11
US California Fields	Aliso Canyon	4.16
	Ant Hill	22.04
	Antelope Hills	6.56
	Antelope Hills, North	20.91
	Arroyo Grande	32.63
	Asphalto	8.00
	Bandini	6.78
	Bardsdale	3.63
	Barham Ranch	2.64
	Beer Nose	2.50
	Belgian Anticline	3.56
	Bellevue	7.52
	Bellevue, West	4.55
	Belmont, Offshore	4.15
	Belridge, North	4.90
	Belridge, South	16.65
	Beverly Hills	4.49
	Big Mountain	2.58
	Blackwells Corner	5.03
	Brea-Olinda	3.17
	Buena Vista	7.56
	Burrel	25.23
	Cabrillo	2.49
	Canal	4.17
	Canfield Ranch	3.99
	Carneros Creek	3.40
	Cascade	2.12
	Casmalia	9.35
	Castaic Hills	2.52
	Cat Canyon	4.13
	Cheviot Hills	3.39
	Chico-Martinez	17.24
	Cienaga Canyon	4.08
	Coalinga	32.82
	Coles Levee, N	4.56
	Coles Levee, S	2.70
	Comanche Point	8.32
	Coyote, East	6.15
	Cuyama, South	14.43
	Cymric	21.48

	Deer Creek	9.96
	Del Valle	4.73
	Devils Den	5.88
	Edison	16.67
	El Segundo	3.77
	Elk Hills	6.30
	Elwood, S., Offshore	3.57
	Fruitvale	3.87
	Greeley	9.60
	Hasley Canyon	2.15
	Helm	3.93
	Holser	3.04
	Honor Rancho	4.09
	Huntington Beach	5.11
	Hyperion	2.05
	Inglewood	9.52
	Jacalitos	2.40
	Jasmin	13.98
	Kern Front	29.65
	Kern River	12.99
	Kettleman Middle Dome	3.70
	Kettleman North Dome	5.14
	Landslide	12.17
	Las Cienegas	4.63
	Livermore	2.56
	Lompoc	19.65
	Long Beach	6.84
	Long Beach Airport	4.02
	Los Angeles Downtown	5.71
	Los Angeles, East	10.02
	Lost Hills	11.18
	Lost Hills, Northwest	3.91
	Lynch Canyon	12.97
	Mahala	2.70
	McCool Ranch	3.32
	McDonald Anticline	4.30
	McKittrick	28.72
	Midway-Sunset	29.27
	Montalvo, West	2.28
	Montebello	14.96
	Monument Junction	3.62
	Mount Poso	11.71
	Mountain View	3.71
	Newhall-Potrero	2.85
	Newport, West	4.38

	Oak Canyon	3.50
	Oak Park	2.48
	Oakridge	2.39
	Oat Mountain	2.59
	Ojai	2.75
	Olive	1.98
	Orcutt	13.35
	Oxnard	9.90
	Paloma	3.51
	Placerita	41.72
	Playa Del Rey	4.58
	Pleito	2.60
	Poso Creek	32.09
	Pyramid Hills	3.34
	Railroad Gap	5.05
	Raisin City	8.72
	Ramona	3.41
	Richfield	4.40
	Rincon	3.93
	Rio Bravo	5.75
	Rio Viejo	2.87
	Riverdale	3.74
	Rose	2.70
	Rosecrans	5.52
	Rosecrans, South	3.11
	Rosedale	6.49
	Rosedale Ranch	8.00
	Round Mountain	27.77
	Russell Ranch	7.56
	Salt Lake	2.67
	Salt Lake, South	3.84
	San Ardo	31.48
	San Miguelito	5.65
	San Vicente	2.47
	Sansinena	2.56
	Santa Clara Avenue	3.49
	Santa Fe Springs	10.50
	Santa Maria Valley	5.15
	Santa Susana	2.93
	Sargent	3.98
	Saticoy	3.33
	Sawtelle	3.18
	Seal Beach	5.08
	Semitropic	3.48
	Sespe	2.79

	Shafter, North	3.01
	Shiells Canyon	3.38
	South Mountain	3.31
	Stockdale	2.13
	Tapia	7.94
	Tapo Canyon, South	2.92
	Tejon	6.49
	Tejon Hills	6.47
	Tejon, North	3.14
	Temescal	2.75
	Ten Section	6.60
	Timber Canyon	2.99
	Torrance	4.49
	Torrey Canyon	2.73
	Union Avenue	3.57
	Ventura	4.61
	Wayside Canyon	1.67
	West Mountain	2.84
	Wheeler Ridge	4.28
	White Wolf	1.88
	Whittier	2.42
	Wilmington	7.02
	Yowlumne	10.62
	Zaca	8.16
US Federal OCS	Beta	1.71
	Carpinteria	2.85
	Dos Cuadras	4.00
	Hondo	5.54
	Hueneme	3.04
	Pescado	5.72
	Point Arguello	14.23
	Point Pedernales	9.38
	Sacate	3.59
	Santa Clara	2.47
	Sockeye	8.35
Default		12.71

Calculation of the 2010 Baseline Crude Average CI Value

The Baseline Crude Average CI is a volume-weighted average of carbon intensity values for crudes supplied to California refineries during the baseline year 2010. Table 2 below shows a breakdown of the sources of crude oil supplied to California refineries during 2010 and the carbon intensity values assigned to these crude sources. All carbon intensity values were calculated using the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Version 1.1 Draft D.

All crude oil produced in and offshore of California is 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.[12] The volume contributions for California federal offshore crudes are based on oil production data obtained from the Bureau of Safety and Environmental Enforcement.[13] The volume contributions of imported crudes are based on oil supply data provided by the California Energy Commission.[14]

Detailed model inputs used to estimate the carbon intensity values are contained in an Excel file.[15] In order to duplicate these carbon intensity values, the "reference year for default flaring intensity" must be set to 2010 (cell M13 of the flaring sheet) and the OPGEE v1.1 bulk assessment tool must be used for all crudes except oil sands mining, for which the Bitumen Extraction and Mining sheet must be utilized. Model inputs for each crude source can be copied from the Excel file into the corresponding cells on the bulk assessment sheet and the Run Assessment button clicked. For a few crudes, additional cells not on the bulk assessment sheet must be modified from defaults. These changes are noted on the model inputs spreadsheets for these crudes.

Table 2: Calculation of Proposed 2010 Baseline Crude Average CI

Country/State	Crude Name	2010 CI (gCO_2/MJ)	2010 Volume (bbl)
	2010 Baseline Crude Average CI	12.71	
Angola	Dalia	9.44	4,669,678
	Girassol	9.95	1,257,982
	Greater Plutonio	9.51	1,116,972
Argentina	Canadon Seco	9.14	1,569,902
	Escalante	9.16	919,027
	Hydra	8.01	379,435
Australia	Pyrenees	5.82	644,757
Brazil	Albacora Leste	6.50	4,399,684
	Frade	6.11	991,259
	Marlim	7.58	13,200,519
	Marlim Sul	8.40	1,780,305
	Ostra	6.60	1,057,309
	Polvo	6.43	986,563

[12] Crude production data copied from the California Department of Conservation, Online Production and Injection Query, http://opi.consrv.ca.gov/opi/opi.dll, (accessed June 6, 2013).
[13] Crude production data downloaded from the Bureau of Safety and Environmental Enforcement web site http://www.data.bsee.gov/homepg/data_center/production/PacificFreeProd.asp, (accessed May 2013 and May 2014).
[14] California Energy Commission, Spreadsheet titled "2010 MCON Import Results 01-28-12 GDS."
[15] MCON Inputs Spreadsheet for 2010 Baseline Crudes, Spreadsheet titled "2010_Baseline_MCON_Inputs_OPGEE_v1.1.xlsx."

Cameroon	Lokele	24.46	600,239
Canada	Albian Heavy Synthetic	20.54	4,560,973
	Cold Lake	19.64	9,736,048
	Federated	7.62	628,364
	Koch Alberta	7.62	189,694
	Mixed Sweet	7.62	1,871,099
	Suncor Synthetic	23.78	2,733,903
	Syncrude Synthetic	21.44	2,847,112
Colombia	Castilla	9.65	7,991,860
	Vasconia	9.39	2,443,605
Ecuador	Napo	9.82	19,552,878
	Oriente	11.15	45,689,775
Iraq	Basra Light	13.21	46,939,835
Neutral Zone	Eocene	7.27	888,546
	Ratawi	9.03	399,494
Nigeria	Bonny	17.58	473,835
Oman	Oman	12.75	4,026,126
Peru	Loreto	8.62	4,165,476
	Mayna	10.19	890,366
Russia	ESPO	13.43	17,802,032
Saudi Arabia	Arab Extra Light	9.16	24,349,999
	Arab Light	9.04	45,755,141
Trinidad	Calypso	7.01	180,527
Venezuela	Boscan	10.09	178,157
	Petrozuata	23.25	721,236
	Zuata	23.22	359,793
US Alaska	ANS	11.53	86,382,000
US North Dakota	Bakken	8.71	496,886
US California*	Aliso Canyon	2.69	84,048
	Ant Hill	23.59	43,710
	Antelope Hills	3.05	165,938
	Antelope Hills, North	13.94	303,269
	Arroyo Grande	30.58	416,513
	Asphalto	7.00	332,117
	Bandini	7.96	12,844
	Bardsdale	5.35	68,440
	Barham Ranch	2.60	78,079
	Belgian Anticline	3.20	50,381
	Bellevue	9.02	24,695
	Bellevue, West	9.17	20,092
	Belmont, Offshore	3.55	874,200

	Belridge, North	4.70	2,931,540
	Belridge, South	15.22	26,485,856
	Beverly Hills	4.42	823,937
	Big Mountain	2.85	32,210
	Brea-Olinda	3.15	1,200,090
	Buena Vista	7.26	730,083
	Cabrillo	2.44	37,747
	Canal	4.42	29,355
	Canfield Ranch	3.82	119,099
	Caneros Creek	3.14	32,125
	Cascade	2.11	176,937
	Casmalia	8.02	172,054
	Castaic Hills	3.06	12,873
	Cat Canyon	4.00	336,451
	Cheviot Hills	3.23	51,020
	Cienaga Canyon	4.26	42,637
	Coalinga	31.40	5,637,795
	Coalinga, East	17.78	21,984
	Coles Levee, N	4.50	149,597
	Coles Levee, S	2.67	87,026
	Coyote, East	5.88	227,133
	Cuyama, South	12.36	218,648
	Cymric	22.62	15,475,608
	Deer Creek	10.17	48,601
	Del Valle	4.56	65,358
	Devils Den	5.58	20,188
	Edison	9.28	757,792
	El Segundo	3.22	20,350
	Elk Hills	5.20	13,941,226
	Elwood, S., Offshore	4.29	870,666
	Fruitvale	11.17	469,295
	Greeley	8.52	132,274
	Hasley Canyon	2.14	45,177
	Helm	3.22	106,799
	Holser	3.21	20,070
	Honor Rancho	3.51	53,687
	Huntington Beach	5.37	1,826,290
	Hyperion	1.93	10,378
	Inglewood	9.36	2,637,787
	Jacalitos	2.54	131,038
	Jasmin	16.07	101,168

	Kern Front	28.57	2,808,120
	Kern River	13.46	27,376,634
	Kettleman Middle Dome	3.92	33,491
	Kettleman North Dome	4.93	37,245
	Landslide	11.14	34,661
	Las Cienegas	4.80	457,276
	Livermore	2.55	16,035
	Lompoc	33.31	208,503
	Long Beach	6.48	1,455,363
	Long Beach Airport	4.10	11,136
	Los Angeles Downtown	4.39	29,604
	Los Angeles, East	8.81	15,837
	Lost Hills	11.71	11,432,041
	Lost Hills, Northwest	4.58	22,420
	Lynch Canyon	7.83	151,861
	McDonald Anticline	5.10	51,224
	McKittrick	20.12	2,016,851
	Midway-Sunset	26.07	32,407,532
	Montalvo, West	2.83	553,607
	Montebello	11.64	729,238
	Monument Junction	3.56	104,188
	Mount Poso	15.48	542,986
	Mountain View	5.01	132,537
	Newhall-Potrero	2.80	143,065
	Newport, West	4.00	97,190
	Oak Canyon	3.60	29,881
	Oak Park	2.27	20,958
	Oakridge	2.75	72,368
	Oat Mountain	2.11	112,638
	Ojai	2.78	262,361
	Olive	2.02	18,486
	Orcutt	12.43	1,079,730
	Oxnard	16.99	118,490
	Paloma	3.55	28,244
	Placerita	48.22	744,659
	Playa Del Rey	5.60	45,518
	Pleito	3.56	248,779
	Poso Creek	30.04	2,486,338
	Pyramid Hills	2.96	62,101
	Railroad Gap	5.17	107,341
	Raisin City	8.05	150,266

	Ramona	3.30	62,490
	Richfield	3.97	379,426
	Rincon	3.60	329,735
	Rio Bravo	5.15	231,146
	Rio Viejo	2.86	82,937
	Riverdale	3.22	82,245
	Rose	2.38	207,887
	Rosecrans	5.55	174,688
	Rosecrans, South	3.32	10,748
	Rosedale	7.41	18,437
	Rosedale Ranch	8.86	183,724
	Round Mountain	31.06	2,726,537
	Russell Ranch	7.92	61,164
	Salt Lake	2.56	44,315
	Salt Lake, South	3.70	61,515
	San Ardo	33.16	6,048,571
	San Miguelito	4.78	613,652
	San Vicente	2.40	308,465
	Sansinena	2.82	152,978
	Santa Clara Avenue	3.48	71,647
	Santa Fe Springs	12.46	649,718
	Santa Maria Valley	5.06	185,697
	Santa Susana	2.86	18,866
	Sargent	4.96	22,844
	Saticoy	3.45	39,377
	Sawtelle	3.00	181,995
	Seal Beach	4.98	457,276
	Semitropic	3.94	33,742
	Sespe	2.84	343,375
	Shafter, North	2.77	724,013
	Shiells Canyon	3.15	88,409
	South Mountain	3.15	418,243
	Stockdale	2.12	94,937
	Strand	2.56	12,713
	Tapia	5.62	54,244
	Tapo Canyon, South	2.94	12,438
	Tejon	5.86	471,295
	Tejon Hills	6.46	15,345
	Tejon, North	3.28	37,156
	Temescal	3.00	28,037
	Ten Section	6.61	104,589

	Timber Canyon	3.12	35,660
	Torrance	4.83	363,262
	Torrey Canyon	2.82	73,651
	Union Avenue	2.05	21,600
	Ventura	4.69	4,552,969
	Wheeler Ridge	4.30	64,928
	White Wolf	1.83	11,989
	Whittier	2.46	107,933
	Wilmington	6.82	13,350,682
	Yowlumne	11.96	238,896
	Zaca	7.99	183,191
US Federal OCS	Beta	1.59	1,564,879
	Carpinteria	2.72	450,083
	Dos Cuadras	3.92	1,158,945
	Hondo	6.05	5,103,155
	Hueneme	2.80	110,313
	Pescado	4.90	3,951,076
	Point Arguello	14.59	1,969,836
	Point Pedernales	6.51	2,134,927
	Sacate	3.47	3,206,868
	Santa Clara	2.36	622,887
	Sockeye	6.86	1,303,256

*All California fields producing 10,000 barrels or more during 2010.

Calculation of 2013 California Average Carbon Intensity

Table 3 below shows a breakdown of the sources of crude oil supplied to California refineries during 2013 and the carbon intensity values assigned to these crude sources. All crude oil produced in and offshore of California is 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.[16] The volume contributions for California federal offshore crudes are based on oil production data obtained from the Bureau of Safety and Environmental Enforcement.[17] The volume contributions of imported crudes are based on oil supply data submitted by refineries as part of annual compliance reporting for 2013. Crude carbon intensity values are from Table 8 (the Crude Lookup Table in section 95486(b)(1)).[18] Forty-two crude names that do not appear in Table 8 were supplied to California refineries during 2013. These crudes contributed only 8.5 percent of the total volume of crude supplied

[16] Crude production data copied from the California Department of Conservation, Online Production and Injection Query, http://opi.consrv.ca.gov/opi/opi.dll, (accessed May 29, 2014).
[17] Bureau of Safety and Environmental Enforcement web site http://www.data.bsee.gov/homepg/data_center/production/PacificFreeProd.asp, (accessed May 2013 and May 2014).
[18] Low Carbon Fuel Standard Regulation Order, November 26, 2012.

to California refineries and are assigned the 2010 Baseline Crude Average CI value of 11.39 gCO_2e/MJ. The 2013 Crude Average carbon intensity, 11.37 gCO_2e/MJ, is calculated by weighting the carbon intensity value for each crude by the volume supplied to California refineries during 2013.

Table 3: 2013 California Average Carbon Intensity Calculation

Country/State	Crude Name	CI (g/MJ)	2013 Volume (bbl)
Algeria	Saharan	11.39	74,260
Angola	Dalia	7.86	2,593,109
	Girassol	10.43	1,583,834
	Greater Plutonio	8.82	2,607,434
	Kissanje	11.39	519,752
	Nemba	11.39	579,161
	Pazflor	11.39	4,019,245
Australia	Enfield	11.39	527,084
Brazil	Albacora Leste	7.35	772,526
	Frade	6.62	430,048
	Jubarte	11.39	168,020
	Lula	11.39	1,920,416
	Marlim	6.75	1,878,263
	Ostra	5.71	930,198
	Roncador	11.39	215
	Roncador Heavy	11.39	1,271,000
	Sapinhoa	11.39	1,032,516
Canada	Access Western Blend	11.39	228,810
	Albian Muskeg River Heavy	11.39	124,000
	Albian Heavy Synthetic	21.02	3,258,978
	Borealis	11.39	386,249
	Bow River	11.39	270,383
	Cardium	11.39	16,611
	Cold Lake	18.74	6,772,240
	Fosterton	11.39	1,060,536
	Halkirk	11.39	35,728
	Koch Alberta	7.61	86,900
	Light Sweet	11.39	37,148
	Peace River Sour	11.39	92,915
	Pembina	11.39	201,500
	Suncor Synthetic (all grades)	24.49	4,898,699
Chad	Doba	11.39	719,359
Colombia	Castilla	6.45	11,754,560

	Cusiana	11.39	69,690
	Magdalena	11.39	3,642,933
	Rubiales	11.39	382,242
	South Blend	11.39	1,595,908
	Vasconia	6.63	7,762,498
Ecuador	Napo	7.45	22,693,813
	Oriente	9.34	44,719,127
Equatorial Guinea	Ceiba	11.39	3,357,194
	Zafiro	11.39	1,035,612
Iraq	Basra Light	12.08	53,485,785
Kuwait	Kuwait	11.39	4,566,220
Mauritania	Chinquetti	11.39	625,062
Neutral Zone	Eocene	5.59	291,620
Nigeria	Antan	11.39	544,019
Oman	Oman	12.30	270,490
Peru	Loreto	5.82	3,685,332
Russia	ESPO	12.09	5,808,606
Saudi Arabia	Arab Extra Light	6.86	19,670,435
	Arab Light	6.75	52,436,845
	Arab Medium	11.39	13,953,374
	Arab Heavy	11.39	813,300
Venezuela	Bachaquero	11.39	266,800
	Boscan	12.53	155,000
	Hamaca DCO	11.39	322,400
	Laguna	11.39	283,440
	Zuata (all grades)	23.50	480,740
US Alaska	ANS	12.81	72,965,982
US Colorado	Niobrara	11.39	642,988
US New Mexico	Four Corners	11.39	454,065
US North Dakota	Bakken	11.39	3,147,501
US Texas	West Texas Intermediate	11.39	279,600
US Utah	Covenant	11.39	519,556
	Utah Sweet	11.39	71,645
US Wyoming	Wyoming	11.39	115,078
US California*	Aliso Canyon	1.97	250,249
	Ant Hill	26.37	51,053
	Antelope Hills	2.69	133,377
	Antelope Hills, North	13.16	242,962
	Arroyo Grande	27.81	366,738
	Asphalto	7.92	250,847
	Bandini	7.75	6,733

	Bardsdale	5.24	114,429
	Barham Ranch	2.74	78,498
	Beer Nose	2.18	35,139
	Belgian Anticline	3.62	42,247
	Bellevue	8.27	20,398
	Bellevue, West	8.63	10,026
	Belmont, Offshore	3.19	701,620
	Belridge, North	5.00	2,513,108
	Belridge, South	14.49	23,527,707
	Beverly Hills	3.33	745,772
	Big Mountain	3.15	28,171
	Blackwells Corner	11.05	9,527
	Brea-Olinda	2.97	1,111,985
	Buena Vista	13.61	1,233,874
	Burrel	16.44	11,871
	Cabrillo	2.84	12,791
	Canal	4.04	28,684
	Canfield Ranch	3.58	114,807
	Caneros Creek	2.96	20,545
	Cascade	2.20	144,353
	Casmalia	11.61	202,648
	Castaic Hills	2.79	9,372
	Cat Canyon	5.09	1,438,877
	Cheviot Hills	3.06	41,971
	Chico-Martinez	3.83	195,601
	Cienaga Canyon	3.89	28,348
	Coalinga	25.36	5,523,804
	Coles Levee, N	3.47	155,665
	Coles Levee, S	4.27	74,596
	Comanche	10.75	31,331
	Coyote, East	5.59	229,482
	Cuyama, South	11.86	212,571
	Cymric	19.91	14,459,179
	Deer Creek	18.29	48,556
	Del Valle	4.30	55,332
	Devils Den	3.63	18,934
	Edison	9.03	786,006
	El Segundo	2.98	30,083
	Elk Hills	5.36	12,418,438
	Elwood, S., Offshore	4.18	1,734,916
	Fruitvale	10.24	431,701

	Greeley	8.14	112,119
	Hasley Canyon	2.07	37,433
	Helm	3.35	56,025
	Holser	3.01	18,242
	Honor Rancho	2.69	64,973
	Huntington Beach	7.80	2,143,415
	Hyperion	1.65	10,848
	Inglewood	8.74	2,731,733
	Jacalitos	2.22	124,723
	Jasmin	17.54	123,904
	Kern Front	25.06	3,447,417
	Kern River	9.55	25,738,315
	Kettleman Middle Dome	3.53	47,090
	Kettleman North Dome	4.70	31,844
	Landslide	10.49	33,929
	Las Cienegas	4.46	337,733
	Livermore	2.17	12,088
	Lompoc	31.05	364,509
	Long Beach	5.12	1,389,178
	Long Beach Airport	3.73	11,329
	Los Angeles Downtown	4.11	23,697
	Los Angeles, East	8.28	22,814
	Lost Hills	11.40	10,762,890
	Lost Hills, Northwest	4.35	25,649
	Lynch Canyon	7.73	160,485
	Mahala	3.57	12,021
	McCool Ranch	1.71	11,388
	McDonald Anticline	4.92	54,787
	McKittrick	15.47	2,513,368
	Midway-Sunset	21.18	28,794,725
	Montalvo, West	2.63	658,941
	Montebello	10.29	572,863
	Monument Junction	3.81	120,059
	Mount Poso	20.57	1,114,063
	Mountain View	4.42	103,790
	Newhall-Potrero	2.83	119,417
	Newport, West	4.33	88,486
	Oak Canyon	3.81	16,255
	Oak Park	2.13	17,005
	Oakridge	2.57	117,458
	Oat Mountain	1.90	86,998

	Ojai	3.27	265,080
	Olive	1.93	73,195
	Orcutt	12.52	1,432,214
	Oxnard	16.89	102,030
	Paloma	3.42	22,861
	Placerita	31.66	942,420
	Playa Del Rey	6.04	33,674
	Pleito	4.01	586,827
	Poso Creek	28.41	2,793,324
	Pyramid Hills	2.92	62,093
	Railroad Gap	6.56	133,231
	Raisin City	7.64	114,381
	Ramona	3.37	46,219
	Richfield	3.63	320,586
	Rincon	2.93	310,729
	Rio Bravo	4.85	353,540
	Rio Viejo	2.50	73,224
	Riverdale	2.99	68,063
	Rose	2.10	463,643
	Rosecrans	5.18	152,981
	Rosecrans, South	3.11	8,592
	Rosedale	6.60	14,719
	Rosedale Ranch	8.84	170,325
	Round Mountain	28.73	4,175,910
	Russell Ranch	6.56	62,098
	Salt Lake	2.82	51,699
	Salt Lake, South	3.68	31,833
	San Ardo	28.82	7,229,422
	San Miguelito	4.44	470,557
	San Vicente	2.31	271,235
	Sansinena	2.54	173,094
	Santa Clara Avenue	3.31	60,971
	Santa Fe Springs	11.34	937,016
	Santa Maria Valley	6.48	229,038
	Santa Susana	3.14	17,820
	Sargent	4.77	35,510
	Saticoy	3.26	36,633
	Sawtelle	2.83	174,433
	Seal Beach	4.07	443,272
	Semitropic	3.39	38,312
	Sespe	2.91	388,345

	Shafter, North	2.54	940,893
	Shiells Canyon	3.24	88,990
	South Mountain	3.10	670,182
	Stockdale	1.71	117,873
	Tapia	6.42	43,455
	Tapo Canyon, South	2.87	8,306
	Tejon	7.96	488,252
	Tejon Hills	5.74	15,359
	Tejon, North	4.72	44,017
	Temescal	3.10	66,503
	Ten Section	6.22	94,873
	Timber Canyon	3.30	38,081
	Torrance	4.45	387,747
	Torrey Canyon	2.88	123,261
	Union Avenue	1.79	13,455
	Ventura	4.35	5,135,029
	Wayside Canyon	2.93	54,060
	West Mountain	2.89	14,743
	Wheeler Ridge	3.34	68,613
	White Wolf	1.64	9,821
	Whittier	2.51	72,634
	Wilmington	6.36	13,858,052
	Yowlumne	11.22	230,670
	Zaca	10.45	215,552
US Federal OCS	Beta	1.74	1,511,235
	Carpinteria	2.62	372,631
	Dos Cuadras	3.83	988,268
	Hondo	4.27	5,120,464
	Hueneme	4.33	107,563
	Pescado	3.45	2,322,478
	Point Arguello	8.68	1,206,958
	Point Pedernales	6.00	1,395,406
	Sacate	2.33	3,558,681
	Santa Clara	2.41	379,709
	Sockeye	5.82	983,983

*All California fields that produced at least 10,000 bbls during 2012 or 2013