

**California Environmental Protection Agency
Air Resources Board
Stationary Source Division**

Supplement Version 2.0 to:

Stationary Source Division, Air Resources Board (February 27, 2009, v.2.1)

**“Detailed California-Modified GREET Pathway for California Reformulated
Gasoline Blendstock for Oxygenate Blending (CARBOB) from Average Crude
Refined in California”**

Release Date: September 12, 2012

Need for a Supplement to the CARBOB Pathway Document

The LCFS regulation considers 2010 as the baseline year against which a ten percent reduction in GHG emissions is mandated by 2020.¹ Because data for crude oil supplied to California refineries in 2010 was not available during development of the original regulation, Lookup Table carbon intensity values for CARBOB (California Reformulated Gasoline Blendstock for Oxygenate Blending) and diesel were based on available crude supply data for the year 2006. At the time, an assumption was made that the carbon intensity for recovery of crude oil supplied to California refineries would not change substantially between 2006 and the 2010 baseline year. This assumption turned out to be incorrect as the percentages of crude recovered using thermal methods, mining and upgrading have increased. Therefore as part of the 2011 Regulatory Amendments to the LCFS, ARB staff proposed updates to the baseline carbon intensity values for CARBOB and diesel using crude oil supply data from the year 2010.

Calculation Methodology for the Baseline Crude Average Carbon Intensity Value

Table 1 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. The percentage contribution of each crude was calculated using oil supply data obtained from the California Energy Commission.^{2,3} The 2010 Baseline Crude Average carbon intensity, 11.39 gCO₂/MJ, was calculated by weighting the carbon intensity values by the percentage contribution to total crude oil supplied to California refineries. Table 2 gives carbon intensity values for fields in California producing 2,000 barrels oil per day or greater. All carbon intensity values were calculated using the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Version 1.0.⁴ A description of the model is provided in the model user guide and technical documentation.⁵ A detailed description of the model inputs used to estimate these carbon intensity values is provided in the attached Excel file.

Baseline Average Carbon Intensity Value for CARBOB

The Baseline Average carbon intensity value for CARBOB, 99.18 gCO₂/MJ, was determined by substituting the 2010 Baseline Crude Average carbon intensity value discussed above for the crude recovery (6.93 gCO₂/MJ) and crude transport (1.14 gCO₂/MJ) values reported in the CARBOB pathway document.⁶

¹ Proposed Regulation to Implement the Low Carbon Fuels Standard, ISOR Volume 1, 2009, page V-7

² California Energy Commission, Energy Almanac Webpage, Oil Sources to California Refineries, viewed on October 6, 2011 at http://energyalmanac.ca.gov/petroleum/statistics/crude_oil_receipts.html.

³ California Energy Commission, Spreadsheet titled "2010 MCON Import Results 01-28-12 GDS".

⁴ El-Houjeiri, H.M. and A.R. Brandt, Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 1.0, September 4, 2012.

⁵ El-Houjeiri, H.M. and A.R. Brandt, Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 1.0, User guide and Technical documentation, August 22, 2012.

⁶ California Air Resources Board, February 27, 2009, Detailed CA-GREET Pathway for California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB) from Average Crude Refined in California, Version 2.1

Table 1: 2010 Baseline Crude Average Carbon Intensity

Country	Crude Description	Percentage	CI (gCO₂e/MJ)
United States	CA Average Crude Production	38.78	12.90
	Alaska North Slope	14.48	12.81
Saudi Arabia	Arab Extra Light	4.08	6.86
	Arab Light	7.67	6.75
Ecuador	Napo	3.28	7.45
	Oriente	7.66	9.34
Iraq	Basra Light	7.87	12.08
Russia	ESPO	2.98	12.09
Canada	Federated	0.11	7.77
	Koch Alberta	0.03	7.61
	Mixed Sweet Blend	0.31	7.75
	Albian Heavy Synthetic	0.76	21.02
	Cold Lake	1.63	18.74
	Suncor Synthetic A	0.21	24.49
	Suncor Synthetic C	0.25	24.49
	Syncrude Sweet	0.48	21.87
Brazil	Albacora Leste	0.74	7.35
	Frade	0.17	6.62
	Marlim	2.21	6.75
	Marlim Sul	0.30	9.69
	Ostra	0.18	5.71
	Polvo	0.17	5.62
Colombia	Castilla Blend	1.34	6.45
	Vasconia	0.41	6.63
Angola	Dalia	0.78	7.86
	Girassol	0.21	10.43
	Greater Plutonio	0.19	8.82
Peru	Loreto	0.70	5.82
	Mayna	0.15	7.14
Oman	Oman Blend	0.67	12.30
Argentina	Canadon Seco	0.26	7.54
	Escalante	0.15	7.51
	Hydra	0.06	8.03
Venezuela	Boscan	0.03	12.53
	Petrozuata	0.12	23.58
	Zuata Sweet	0.06	23.50
Kuwait	Eocene (Wafra)	0.15	5.59
	Ratawi (Wafra)	0.07	5.77
Australia	Pyrenees	0.11	5.96
Cameroon	Lokele	0.10	24.02
Nigeria	Bonny Light	0.08	17.88
Trinidad	Calypso	0.03	6.95
2010 Baseline Crude Average		100.00	11.39

Table 2: 2010 Carbon Intensity Values for California Fields (> 2000 BOPD)

Field	Production (BOPD)	CI (gCO₂e/MJ)
Midway-Sunset	88,788	21.18
Kern River	75,004	9.55
Belridge, South	72,522	14.49
Cymric	42,399	19.91
Wilmington	36,577	6.36
Elk Hills	35,548	5.36
Lost Hills	31,321	11.40
San Ardo	16,571	28.82
Coalinga	15,448	25.36
Hondo	13,935	4.27
Ventura	12,474	4.35
Pescado	11,201	3.45
Sacate	8,690	2.33
Belridge, North	8,045	5.00
Kern Front	7,693	25.06
Round Mountain	7,331	28.73
Inglewood	7,227	8.74
Poso Creek	6,812	28.41
Point Pedernales	6,025	6.00
Point Arguello	5,726	8.68
McKittrick	5,526	15.47
Huntington Beach	5,004	7.80
Long Beach	3,987	5.12
Beta	3,939	1.74
Sockeye	3,613	5.82
Brea-Olinda	3,288	2.97
Dos Cuadras	3,173	3.83
Orcutt	2,947	12.52
Belmont, Offshore	2,395	3.19
Elwood, S., Offshore	2,385	4.18
Beverly Hills	2,244	3.33
Edison	2,044	9.03
Placerita	2,040	31.66
Buena Vista	2,000	13.61
All Others	51,336	6.69