Oregon Department of Environmental Quality

Supporting Documentation for OR-GREET Updates

Clean Fuels Program 2024 Rulemaking

This document provides supporting information and data for the updates DEQ is considering for the Oregon Greenhouse gases, Regulated Emissions, and Energy in Transportation (OR-GREET) model. DEQ is updating our model in concert with updates that the California Air Resources Board has proposed for the CA-GREET model, information on those updates can be found here: https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-public-comment

DEQ is issuing this document for our January 30th rulemaking document, and we are requesting public comments on any aspect of the model update be emailed to CFP.2024@deq.oregon.gov by no later than 5pm on February 16, 2024 in order for us to consider them before the first Rulemaking Advisory Committee meeting for this rulemaking.

DEQ is working on updating the full OR-GREET 4.0 model and the Tier 1 simplified calculators for various fuels and will provide draft versions of them for comment later on in this rulemaking.

OR-GREET 4.0 Model Updates

Inputs and Emissions Factors in OR-GREET 4.0

The Oregon Clean Fuels Program uses a "well to wheel" life cycle assessment (LCA) to calculate the carbon intensity (CI) of liquid transportation fuels. To determine each fuel pathway's CI, the greenhouse gas (GHG) emissions from all steps in the fuel's life cycle are summed, adjusted to carbon dioxide equivalent (CO_2e), and divided by the fuel's energy content in megajoules. Cabon intensity is then expressed in terms of grams of CO_2 equivalent per megajoule (gCO_2e/MJ).

The OR-GREET 4.0 model is a modified version of the Argonne GREET1 2022 model[1] to reflect Oregon-specific fuel pathways. Modifications are based on data sources which include the EPA Emissions and Generation Resources Integrated Database (eGRID)[2], the Oil Production

[1] Wang, M., Elgowainy, A., Uisung, L., Kwang, B., Bafana, A., Benavides, P., Burnham, A., Cai, H., Cappello, V., Chen, P., gan, Y., Gracida-Alvarez, U., Hawkins, T., Iyer, R., Kelly, J., Kim, T., Kumar, S., Kwon, H., Lee, K., Liu, X., Lu, Z., Masum, F., Mg, C., Ou, L., Reddi, K., Siddique, N., Sun, P., Vyawahare, P. Xu, H., & Zaimes, G., GREET1 2022, October Release. Center for Transportation Research, Argonne National Laboratory (Accessed on November 11, 2022). https://greet.anl.gov/greet_excel_model.model.

[2] United States Environmental Protection Agency, eGRID+Data.xls. (Updated on January 30, 2023). https://www.epa.gov/system/files/documents/2023-01/eGRID2021_data.xlsx

Greenhouse Gas Emissions Estimator (OPGEE3.0b)[3], Emission FACtor (EMFAC2021)[4], and other sources. This document describes modifications made to the GREET 2022 model to develop the OR-GREET 4.0 model.

The CIs can be calculated using the DEQ approved Tier 1 CI calculators or using modified Tier 1 calculators of the OR-GREET 4.0 model for a Tier 2 pathway. The Tier 1 calculators mostly use emissions factors and inputs obtained from the OR-GREET 4.0 model.

Modifications Incorporated in OR-GREET 4.0

Electricity

The Argonne GREET1 2022 model uses 10-region North American Electric Reliability Corporation (NERC) map to develop region-specific GHG emissions for electricity generation. In OR-GREET 4.0, DEQ uses the U.S. EPA's Emissions and Generation Resource Integrated Database (eGRID) for 2021[5] to determine the impact of stationary electricity use in fuel and feedstock production. The eGRID contains 27 subregions to capture subregional variability in GHG emissions for electricity generation and is used in fuel pathway CIs to ensure consistency across all subregions, in and outside the state. These changes mainly appear through updates to the electricity resources mixes and subregions in the "Fuel_Prod_TS" worksheet of GREET1 2022 and the associated links to the "Inputs" worksheet. The CFP staff will also include mixes such as U.S. Average, Oregon grid mix (ORMX)[6], User Defined, Brazilian Average, and Canadian Averages, making a total of 32 electricity mixes. In accordance with the CA-GREET 4.0 model, OR-GREET 4.0 proposed to adopt a 6.5% electricity transmission and distribution loss factor for all North America regions, encompassing subregions in the U.S. and Canada. The same loss factor for Brazilian electricity in the model will be set at 8.1%.

To determine the CI of Oregon average grid electricity used directly as a transportation fuel (e.g., electricity used for EV charging or fixed guideway transit), the electricity resource mix is based on the Office of Greenhouse Gas Reporting Programs stationary source data[7]. The resources mix data for the 27 eGRID regions in the U.S. are shown in Table 1. The electricity resource mixes for Brazil and Canada are based on EIA data[8] (Table 2).

Oregon Crude Oil Extraction and Transport

The emission factors associated with crude oil extraction and transport used in modeling well-to-wheel GHG emissions of petroleum products will be derived from OPGEE 3.0b model for the

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[3] Brandt, A.R., Masnadi, M.S, Rutherford, J.S., El-Houjeiri, Vafi, K., H.M., Langfitt Q., Duffy, J., Sleep, S., Pacheco, D., Dadashi, Z., Orellana, A., MacLean, H., McNally, S., Englander, J., & Bergerson, J., Oil Production Greenhouse Gas Emissions Estimator OPGEE v.3.0b. (Updated on May 14, 2022). https://eao.stanford.edu/research-project/opgee-oil-production-greenhouse-gas-emissions-estimator

[4] California Air Resources Board, EMFAC2021. v1.0.2. (Updated April 2021). https://arb.ca.gov/emfac/

[5] United States Environmental Protection Agency, eGRID+Data.xls. (Updated on January 30, 2023). https://www.epa.gov/system/files/documents/2023-01/eGRID2021_data.xlsx

[6] Oregon Clean Fuels Program. cfpElectricCIV2023.pdf (oregon.gov)

[7] Oregon Greenhouse Gas Reporting Program. https://www.oregon.gov/deq/ghgp/pages/ghg-reporting.aspx

[8] IEA, Countries & Regions. (Accessed October 2023). https://www.iea.org/countries

OR-GREET 4.0 model. Details of these updates will be provided in a Technical Support Document later on in this rulemaking.

Ocean Tanker and Truck Transport

A backhaul energy intensity of 85.7 btu/ton-mile corresponding to the payload of 35,000 deadweight tonnage (DWT) is added to ocean tanker transport for Brazilian sugarcane ethanol based on the data provided by fuel suppliers. The ocean tanker transport emission factors for other alternative fuels and feedstocks used in the Tier 1 calculators are derived from the ocean tanker with three payload or DWT sizes: 12,500 DWT, 22,500 DWT, and 35,000 DWT.

The fuel economy (miles per gallon) of medium heavy-duty truck (MHDT) and heavy heavy-duty truck (HHDT) are updated with fuel economy data obtained from EMFAC2021 (v1.0.2). The payload of HHDT for corn transport is revised from 15 tons to 25 tons. This is supported by the fact that the payload of HHDT for sorghum transport is also 25 tons in the GREET1 2022 model. These revisions are consistent with the CA-GREET model updates for CA-GREET4.0. Additional details will be provided in a Technical Support Document later on in this rulemaking.

Tailpipe Emissions Factors

Tailpipe emission factors for natural gas and ULSD are determined based on the EMFAC2021 (v1.0.2) model4 and the carbon content of fuels. This same methodology is applied to calculate CARBOB and CaRFG values pertinent to fuels used in California, as accounted for in the CA-GREET4.0 model. These values are incorporated into fuel pathways certified under the California LCFS and subsequently recertified under the Oregon CFP (i.e., recertification pathways). Fuel pathway holders for these pathways have the option to use either the OR-GREET or CA-GREET model. Details will be provided in a Technical Support Document later on in this rulemaking.

The tailpipe CH_4 and N_2O emissions from the use of propane in light duty propane vehicles are calculated using the values from the Argonne GREET1 2022 model1. CO_2 emissions are calculated based on carbon content in propane. Details of these updates will be provided in a Technical Support Document later on in this rulemaking.

The tailpipe emissions of conventional jet fuel will be provided in the “JetFuel_WTP” worksheet which are obtained from OR-GREET 3.0 for CH_4 and N_2O. CO_2 emissions are calculated based on the carbon content of conventional jet fuel in OR-GREET 4.0, in accordance with the CA-GREET model updates for CA-GREET 4.0.

The tailpipe emission factors for biodiesel, renewable diesel, and alternative jet fuel are derived from OR-GREET 3.0.

Tallow and UCO Rendering Emissions

The allocated rendering energy for tallow and UCO is 3,944 btu/lb and 1,073 btu/lb, respectively, in accordance with CA-GREET 4.0. The data provided by rendering facilities suggests that these rendering energy data are accurate and conservative.

Fuel Specifications

Fuel specifications, especially heating values (HHV and LHV) and densities of gases in OR-GREET4.0 are adjusted to reflect ambient temperature at 60°F and pressure at 1 atm, as it is the standard reference condition used in commercial transactions by the oil and gas industries. Details are summarized in Table 3.

Table 1: Electricity Resource Mixes in 27 eGRID subregions in the U.S. 2021 Values

eGRID subregion acronym	Coal	Oil	Gas	Nuclear	Hydro	Biomass	Wind	Solar	Geothermal
AKGD	15.3%	9.8%	60.6%	0.0%	11.5%	0.8%	2.1%	0.0%	0.0%
AKMS	0.0%	25.1%	6.1%	0.0%	67.0%	0.0%	1.8%	0.0%	0.0%
AZNM	16.0%	0.1%	46.8%	18.8%	3.4%	0.4%	5.2%	6.0%	0.0%
CAMX	3.8%	0.8%	47.7%	8.1%	6.6%	2.5%	7.7%	18.9%	0.0%
ERCT	17.7%	0.5%	46.6%	9.5%	0.2%	0.2%	21.8%	3.5%	0.0%
FRCC	7.7%	1.2%	74.0%	11.8%	0.1%	1.5%	0.0%	3.6%	0.0%
HIMS	0.0%	64.3%	0.0%	0.0%	4.4%	3.7%	14.8%	5.9%	0.0%
HIOA	16.5%	71.1%	0.0%	0.0%	0.0%	2.8%	4.1%	5.4%	0.0%
MROE	54.4%	1.2%	32.1%	0.0%	4.9%	3.0%	3.1%	1.3%	0.0%
MROW	39.6%	0.3%	10.8%	8.6%	4.4%	0.8%	34.6%	0.9%	0.0%
NEWE	0.6%	1.9%	54.4%	26.3%	5.7%	5.3%	3.7%	2.4%	0.0%
NWPP	19.0%	0.4%	21.2%	3.0%	40.8%	1.1%	11.5%	2.3%	0.0%
NYCW	0.0%	0.7%	90.1%	8.7%	0.0%	0.4%	0.0%	0.0%	0.0%
NYLI	0.0%	9.4%	85.4%	0.0%	0.0%	3.5%	0.0%	1.8%	0.0%
NYUP	0.0%	0.4%	25.9%	33.2%	33.2%	1.6%	4.9%	0.9%	0.0%
PRMS	17.5%	37.2%	42.8%	0.0%	0.0%	0.0%	0.0%	1.6%	0.0%
RFCE	10.3%	0.8%	48.7%	36.0%	1.4%	1.0%	1.0%	0.8%	0.0%
RFCM	39.1%	2.6%	31.0%	17.3%	0.0%	1.5%	8.1%	0.4%	0.0%
RFCW	35.6%	1.0%	27.8%	28.5%	1.1%	0.5%	5.2%	0.3%	0.0%
RMPA	39.7%	0.1%	23.0%	0.0%	9.4%	0.3%	25.0%	2.6%	0.0%
SPNO	40.6%	0.4%	9.5%	11.7%	0.2%	0.1%	37.3%	0.1%	0.0%
SPSO	26.8%	1.9%	36.2%	0.0%	4.1%	1.2%	29.4%	0.4%	0.0%
SRMV	11.1%	2.0%	59.0%	24.9%	1.6%	1.0%	0.0%	0.3%	0.0%
SRMW	67.4%	0.1%	11.2%	11.1%	1.7%	0.1%	7.9%	0.4%	0.0%
SRSO	19.2%	0.1%	51.5%	19.3%	3.4%	4.1%	0.0%	2.3%	0.0%
SRTV	31.6%	0.1%	26.2%	30.9%	10.1%	0.8%	0.0%	0.3%	0.0%
SRVC	13.4%	0.4%	38.1%	38.8	1.9%	2.3%	0.4%	4.7%	0.0%

Table 2. Electricity Resource Mixes in Brazil and Canada and Oregon

Data Year	Country	Coal	Oil	Gas	Nuclear	Hydro	Biomass	Wind	Solar
2020	Brazil	3.19%	1.77%	8.61%	2.26%	63.80%	9.46%	9.18%	1.73%
2021	Canada	5.77%	0.78%	11.89%	14.40%	59.24%	1.59%	5.53%	0.80%
2021	Oregon	14.05%	0.01%	19.05%	3.07%	30.53%	0.18%	9.00%	2.49%

Table 3. Updated Specifications of Various Gases (at 60˚F, 1 atm)

Specification	LHV	HHV	Density
	Btu/ft3	Btu/ft3	grams/ft3
Natural gas	930	1,030	20.80
Gaseous hydrogen	274	325	2.41
Pure methane	910	1010	19.20
Carbon dioxide			53.00
Still gas (in refineries)	929	987	19.20

Contact

For questions on this document please email CFP.2024@deq.oregon.gov

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