Formula Worksheet - Allocating Oil Refinery CO2 Emissions to a Gasoline Powered Automobile in Grams Per Mile Driven

$$GV_{er}\ \frac{CO_2\ grams}{mile} = \frac{\alpha\ CO_{2e}\ metric\ ton \times \frac{1000000\ grams}{metric\ ton}}{\beta\ gallons} \times \gamma \frac{gallon}{mile} = \frac{\alpha}{\beta \times \gamma}\ \frac{CO_2\ grams}{mile}$$

$$GV_{et}\ \frac{CO_2\ grams}{mile} = GV_{er}\ \frac{CO_2\ grams}{mile} + GV_{ed}\ \frac{CO_2\ grams}{mile}$$

where:

GV_{er} = a gasoline powered vehicle's emissions allocated from oil refining.

$GV_{ed}\ \frac{CO_2\ grams}{mile}$ = a gasoline powered vehicle's emissions burning gasoline while driving. The U.S. average is 404 $\frac{CO_2\ grams}{mile}$.

Data source: For most consumer electric cars, the Environmental Protection Agency has already done these computations and the result can be looked up using:

U.S. Environmental Protection Agency. 2018a. Find and Compare Cars (Fuel economy andenvironmental impacts by year, make and model, database).

https://www.fueleconomy.gov/

For e-scooters and e-bikes, use the worksheet: "Estimating Driving CO2 Emissions Grams Per Mile Driven for Electric Vehicles".

GV_{et} = a gasoline powered vehicle's total emissions

CO_{2e} = CO2 emissions.

α = metric tons of CO2 emitted by all oil refineries in your state.

Data source: U.S. Environmental Protection Agency. 2018b. EPA Facility Level Infomration on Greenhouse Gases Tool (Flight). Internet database.

https://ghgdata.epa.gov/ghgp/main.do#/facility/

β = gallons of gasoline refined by all the oil companies in your state.

Data source: Your state petroluem association or state energy office.

Example For Utah: Utah Petroluem Association. http://www.utahpetroleum.org/

γ= gallons per mile rating for your car. U.S. average for all automobiles is 22 miles per gallon highway in 2018.

Data source: U.S. Environmental Protection Agency. 2018a. Find and Compare Cars (Fuel economy andenvironmental impacts by year, make and model, database).

https://www.fueleconomy.gov/

Example computation for Utah's five oil refineries the produce gasoline used in Salt Lake City, Utah (*See* main paper):

$$evalf\left(\frac{2100000 \times 1000000}{1745331000 \times 22}\right)\frac{CO_2\ grams}{mile}$$

$$\frac{54.69137112\ CO_2\ grams}{mile} \tag{1}$$

$$54.7\ \frac{CO_2\ grams}{mile} + 404\ \frac{CO_2\ grams}{mile}$$

$$\frac{458.7\ CO_2\ grams}{mile} \tag{2}$$

Kurt A. Fisher November 28, 2018 "Dockless E-scooter CO2 Emissions: An Early Analysis for Salt Lake City"