WORKSHEET FOR DOCKLESS E-SCOOTER CO2 EMISSIONS - SALT LAKE CITY

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1.1. **E-scooter characteristics.** Segway ES4
Top Speed: 19 mph (crippled to 15 mph for Lime and Bird scooters)
Range: 28 miles
Battery capacity: 374 watt-hours

GenZe 200 Series E-bike
Range: 15-18 miles
Speed: 20 mph
Battery Capacity: 36 volt, 9.6 amp hours = 345 watt hours

GenZe 2.0 Vespa-like scooter:
Range: 35 miles
Speed: 30 mph
Battery Capacity: 2000 Watt-hours

Segway ES4 E-scooter CO2 grams/miles = Average CO2 grams per watt-hour from electric grid times 374 watt hours divided 28 miles.

1.2. **Utah electric grid CO2 emissions per watt hour and kwh.** Utah coal-natural-gas electric grid average
31,133,928 x 1,000,000 metric tons of CO2
divided by 28,244,970 x 1,000,000 watt hours
divided by 0.957 transmission loss
==========
equal 1.15 grams of CO2 per watt hour
or 1.15 kilograms of CO2 per kilo watt hour

Utah natural-gas electric grid only average
3,740,766 metric tons of CO2
divided by 8,691,720 megawatt hours
divided by 0.957 transmission loss
==========
equal 0.430 grams of CO2 per watt hour
or 0.430 kilogram of CO2 per kilo watt hour

1.3. **E-scooter CO2 driving emissions.** Segway ES4 e-scooter, the estimated grams of CO2 per mile under two scenarios:
For Utah average CO2 electric generation emissions:
1.15 grams of CO2 per watt hour
times 374 watt-hours of battery capacity.
divided by 28 mile range
==========
15.4 grams of CO2 per mile

For Utah natural Gas CO2 electric generation emissions only:
0.430 grams of CO2 per watt hour
times 374 watt-hours of battery capacity.
divided by 28 mile range
==========
5.74 grams of CO2 per mile

GenZe 200 Series E-bike
For Utah average CO2 electric generation emissions:
1.15 grams of CO2 per watt hour
times 345 watt-hours of battery capacity.
divided by 18 mile range
==========
22 grams of CO2 per mile

GenZe 2.0 Vespa-like scooter:
For Utah average CO2 electric generation emissions:
1.15 grams of CO2 per watt hour
times 2000 watt-hours of battery capacity.
divided by 35 mile range
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65 grams of CO2 per mile

1.4. **CO2 emissions from recharging and re-balancing vans.** 1) Ford 150 trucks pulling a trailer and carrying about 10 Bird scooters. The Ford 150 is rated at about 19 per gallon in the city. Given the nature of e-scooter picks, I assume that they get on average 14.6 miles per gallon in the city.

2) Ford Transit cargo vans picking up about 10 Lime scooters that get about 21 miles per gallon in the city. I assume that they get on average 14.6 miles per gallon in the city.

For both vehicles scenarios, this equates to an assumed 600 grams of CO2 emissions per mile.
300 grams of CO2 per scooter per day = 5 miles x 600 grams CO2 per mile /10 scooters
600 grams of CO2 per scooter per day = 10 miles x 600 grams CO2 per mile /10 scooters

1.5. **How far and how many times are dockless e-scooters driven each day?** For Salt Lake City, the Bird estimate of 5 rides at 1.5 miles per ride

1.6. **What is the total allocation of CO2 emissions for 7.5 miles of e-scooter travel?** Utah Average Electricity Grid:
715 grams CO2 to travel 7.5 miles = 600 grams of CO2 for daily recharge and redistribution + 15.4 grams per mile CO2 during 7.5 miles of travel.

Utah Natural Gas Only Electricity Grid:
642 grams CO2 to travel 7.5 miles = 600 grams of CO2 for daily recharge and redistribution + 5.7 grams per mile CO2 during 7.5 miles of travel.

1.7. **How much CO2 do automobiles emit when burning gasoline?** How much does a car emit? The EPA estimates the average U.S. automobile emits 404 grams of CO2 per mile (US EPA March 2018). If the upstream electricity generation CO2 emissions are included, a 2018 Chevrolet Bolt All-electric vehicle emits 90 grams per mile when driven in the Salt Lake area and 170 grams per mile on average in the United States (US EPA 2018). A 2015 Prius emits 133 grams of CO2 per mile. A 2016 Ford 150 truck about 409 grams per mile (US EPA 2018).

1.8. **How much CO2 is emitted to refine the gasoline that goes into an automobile and to transport that gasoline to a local station?** Utah's Five Refineries
2,100,000 metric tons of CO2
x 1,000,000 grams per metric ton
divided by 1,745,331,000 gallons
==========
1,263 grams of CO2 emitted to refine one gallon of gasoline.

This estimate comports with another non-authoritative estimate that refining a gallon of gasoline generates 2.4581 lbs or 1,114 grams of CO2 emissions (Serpa 2008).

At 22 miles per gallon, your auto also has caused to be generated another 57 grams of CO2 to refine the gasoline burned by the car (1,263 grams per gallon divided by 22 miles per gallon).

1.9. **What is the total CO2 emitted for automobiles per mile for a 7.5 mile trip?** 3,427 CO2 grams for 7.5 miles = 457 CO2 grams per mile x 7.5 miles.

1.10. **What is ratio of total CO2 emissions for dockless e-scooters and automobiles?** Utah Average Electricity Grid:
715 grams CO2 per 7.5 miles per scooter / 3427 grams CO2 per 7.5 miles per automobile = 0.21 (1 in 5)
Utah Natural Gas Only Electricity Grid:
642 grams CO2 per 7.5 miles per scooter /3427 grams CO2 per 7.5 miles per automobile = 0.19 (1 in 6)

About: I am a mathematics student and not an expert on energy or transportation policy. I am supportive of e-scooter technology except that dockless sharing escooters do not carry liability insurance.

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