Uber's Electrification Update: methodology

Vehicle fuel type identification and efficiency estimation
Emissions calculation
Carbon intensity calculation

Introduction

At Uber, we aim to be transparent about our progress. With that in mind, this update serves to provide a high-level synopsis of how we identify vehicle fuel types and estimate vehicle efficiency, estimate the emissions from trips arranged on our platform, and determine the carbon intensity of the platform.

Uber has 3 primary lines of business:

- **Mobility:** Point-to-point on-demand passenger mobility services (such as the UberX ride option)
- **Delivery:** Food and item last-mile delivery services (for instance, through Uber Eats, Uber Direct, or Postmates)[1]
- **Freight:** Global shipping of goods by heavy-duty truck, LTL (less than truckload), rail, ocean, and air, along with transportation network management and services (Uber Freight)

For each line of business, we identify 3 distinct driver states—P1, P2, and P3:

State	Driver behavior	Uber's Driver app	Other gig work app (including other TNC and delivery apps)
Open (P1)	Waiting for a request	On	Possibly on
On the way (P2)	Accepted request, heading to pickup location	On	Likely off
On-trip (P3)	Picked up rider(s)/delivery, heading to dropoff location	On	Likely off

[1]We exclude self-pickup orders, as those do not contribute to Uber delivery miles or emissions.

For Mobility and Delivery, we calculate tank-to-wheel (TTW) emissions for distance driven in each P1-P3 state. Note that distance data for the P1 period is less reliable. Once calculated, we estimate well-to-wheel (WTW) emissions by applying a WTW/TTW ratio by fuel type.

For Freight, we calculate TTW and WTW emissions by applying emissions factors to P3 trip distances. Emissions associated with P2 states, or deadheading, are embedded within these factors (there is no analogous P1 state for Freight, as trucks using Uber Freight do not drive around waiting for a request).

Vehicle fuel type identification and efficiency estimation (Mobility and Delivery)

Belgium, Canada, Germany, the Netherlands, Portugal, Spain, and the US

We rely mainly on vehicle identification numbers (VINs) to identify a driver's vehicle details. Each vehicle has a unique VIN, and we source vehicle details per VIN from third-party data providers. This decoding returns fuel type (gasoline or diesel), engine type (hybrid, internal combustion, electric), and estimated fuel or emission efficiency (such as fuel consumption per distance, like mpg) for each vehicle. When VIN decoding is unsuccessful or unavailable, we use the following fallback methods to impute vehicle data:

1. Assign average emission intensity of active vehicles in the same make/model/year (MMY) in the same region using third-party data for VINs that did successfully decode (MMY must have at least 3 active vehicles with fuel or emission efficiency data).
2. As of Q3 2023, if the MM of the vehicle corresponds with an MM that is only associated with zero-emission vehicles (ZEVs), that vehicle is tagged as a ZEV.
3. Assign continent-level vehicle efficiency estimates. For Canada and the US, assign fuel efficiency of 22.2 mpg (average fuel efficiency for light-duty vehicles in 2019, per US Department of Transportation) and assume gasoline car with non-hybrid internal combustion engine. (This fallback is rarely used for the US and Canada. Vehicles in those 2 countries that are not VIN-decoded are primarily captured by the first fallback.) For vehicles in the rest of the countries that have model year data, use European Environment Agency average emission efficiency data for that year. For example, if the vehicle has a model year of 2020, assign average emission efficiency for 2020 newly sold vehicles.

Australia, France, India, and the UK

In France and India, we identify ZEVs based on vehicle registration information. In Australia and the UK, our operations team has a manual process for tagging ZEVs. We default to those systems, then fall back to the methods outlined above for Belgium, Canada, Germany, the Netherlands, Portugal, Spain, and the US.

The rest of the world

For all other regions/countries, we assign average country-level emission intensity based on the IEA./ICCT (International Council on Clean Transportation) report. For Brazil, we apply some modifications to capture the improvement in emission intensity over time, based on the IHS report.

As of Q3 2023, if the MM of the vehicle corresponds with an MM that is only associated with zero-emission vehicles (ZEVs), that vehicle is tagged as a ZEV.

Vehicles with capacity for 10+ passengers

Whenever trips are completed by vehicles with passenger capacity of 10+ (for instance, Uber Bus), we use country-level emission efficiency based on the IEA/ICCT report (here) with premium factor (4x). This 4x number is based on AFDC's study using US data, but paratransit shuttle and school bus fuel economy is only about one-quarter of ridesharing vehicles. The report gives, for example, 198gCO_2/km as emission efficiency for the US. So for US vehicles with passenger capacity of 10+, emission efficiency is calculated at 198 x 4 = 792gCO_2/km.

Motorcycles and 3-wheelers

According to *Scientific American*, auto-rickshaws have one-third of LDV CO_2 emissions. Based on this, whenever a trip is completed by 3-wheel vehicles, we use country-level emission efficiency based on IEA/ICCT report (here) with discount factor (1/3).

Emissions calculation (Mobility and Delivery)

Canada and the US

With identified fuel-efficiency and fuel-type data, we use the following formula to estimate tank-to-wheel (TTW) fuel consumption and emissions:

$$CO_2 = \sum_{s,f}\left(\frac{vehicle\ distance\ traveled_s}{fuel\ efficiency_{s,f}} \times emission\ factor_f\right)$$

Where:

- CO_2 is TTW CO_2 emissions from the target driver state (either P1, P2, or P3, as defined above) in gCO_2
- $vehicle\ distance\ traveled_s$ is vehicle miles traveled of driver state s
- $fuel\ efficiency_{s,f}$ is fuel efficiency of the vehicle used for driver state s and fuel type f (when the average driver-state speed is less than 30 miles per hour, we use city mpg; when the average driver-state speed is 30 mph or higher, we use highway mpg)
- $emission\ factor_f$ is CO_2 emitted per unit fuel for fuel type f

Emission factors

Fuel type	Emissions in grams CO_2 per gallon (tank-to-wheel)
• Gasoline	8,887

• Flex fuel • Electric with gas generator • Gas/electric hybrid • Plug-in gas/electric hybrid	
• CNG (compressed natural gas) • Propane • Natural gas	5,680
• Biodiesel	9,450
• Diesel • Diesel/electric hybrid	10,180
• Electric • Hydrogen fuel cell	0

The rest of the world

Outside of North America, we use emission efficiency instead of fuel efficiency due to data coverage issues to estimate TTW emissions.

$$CO_2 = \sum_{s,c}\left(vehicle\ km\ traveled_{s,c} \times emission\ efficiency_{s,c}\right)$$

Where:

- CO_2 is TTW CO_2 emissions from the target driver state in gCO_2
- $vehicle\ km\ traveled_{s,c}$ is vehicle km traveled of driver state s per country c
- $emission\ efficiency_{s,c}$ is the efficiency of the vehicle used for the driver state s per country c in gCO_2 per km

Well-to-wheel (WTW) emissions calculation

After calculating TTW emissions, we scale up to WTW at the fuel-type level. For non-ZEVs, we use WTW/TTW ratio as a scaling factor on total TTW emissions produced. For ZEVs, we use per-mile well-to-tank emissions as a scaling factor on total vehicle miles traveled:

$$WTW\ CO_2 = \sum_{f\_nz}\left(TTW\ CO_{2\ f\_nz} \times scaling\ factor_{f\_nz}\right) + \sum_{f\_z}\left(distance_{f\_z} \times scaling\ factor_{f\_z}\right)$$

Where:

- $WTW\ CO_2$ is total well-to-wheel CO_2 emissions in gCO_2

- $TTW\ CO_{2\,f\_nz}$ is total tank-to-wheel CO_2 emissions per fuel type f for non-ZEV vehicles nz aggregated across all driver states (P1, P2, P3)
- $scaling\ factor_{f\_nz}$ is the WTW/TTW ratio per fuel type f for non-ZEV vehicles nz
- $distance_{f\_z}$ is the vehicle distance traveled per fuel type f for ZEV vehicles z aggregated across all driver states (P1, P2, P3) in miles
- $scaling\ factor_{f\_z}$ is the per-mile well-to-tank emissions per fuel type f for ZEV vehicles z in gCO_2 per mile

Scaling factors are derived from IEA (International Energy Agency) data. In all cases, we use the Stated Policies Scenario (STEPS) assumptions, which have the most conservative scaling factors. Note that the IEA does not have information on biodiesel vehicles; in this case, WTW/TTW ratio is derived from data from Defra (the UK's Department for Environment, Food & Rural Affairs).

Non-ZEV scaling factors

Fuel type	**WTW/TTW ratio**	**Source**
• Diesel • Diesel hybrid	1.165	IEA
• Gas/electric hybrid	1.188	IEA
• Plug-in gas/electric hybrid	2.031	IEA
• Gasoline • Flex fuel	1.191	IEA
• CNG (compressed natural gas) • Propane • Natural gas	1.250	IEA
• Biodiesel	3.502	Defra

ZEV scaling factors

Fuel type	Per-mile well-to-tank emissions (gCO_2/mi)	Source
• Electric	112.654	IEA
• Hydrogen fuel cell	183.465	IEA

Emissions calculation (Freight)

Carbon dioxide emissions from our Freight business are estimated based on the emissions calculation framework recommended by the Global Logistics Emissions Council (GLEC). Emissions are calculated based on vehicle miles traveled, load weight, and shipping-category-specific emissions factors. Emissions associated with deadheading—meaning vehicle miles or kilometers traveled without a passenger, in the P1 and P2 states—are embedded within the GLEC factors. The following formula is used to estimate emissions:

$$CO_2 = \sum_{s,m} \left(weight_s \times distance_s \times intensity\ factor_m \right)$$

Where:

- CO_2 is TTW or WTW CO_2 emissions from the target delivery in gCO_2
- $weight$ is load weight, in metric tonnes, per shipment s
- $distance$ is delivery distance, in kilometers, per shipment s
- $intensity\ factor$ is gCO_2 emitted per tonne x kilometer, per mode type m

Note: GLEC includes intensity factors for TTW and WTW emissions, so we do not need to scale up from TTW to WTW.

Carbon intensity calculation (Mobility)

Passenger carbon intensity, or the estimated grams of CO_2 per passenger distance traveled, is an efficiency metric used by Uber—and, increasingly, governments and companies around the world. In the case of ridesharing, emissions produced by any deadhead distance are factored into the calculation, in addition to emissions produced from on-trip distance. The estimated number of passengers per trip, as estimated by a driver-level survey, is also factored into the calculation.

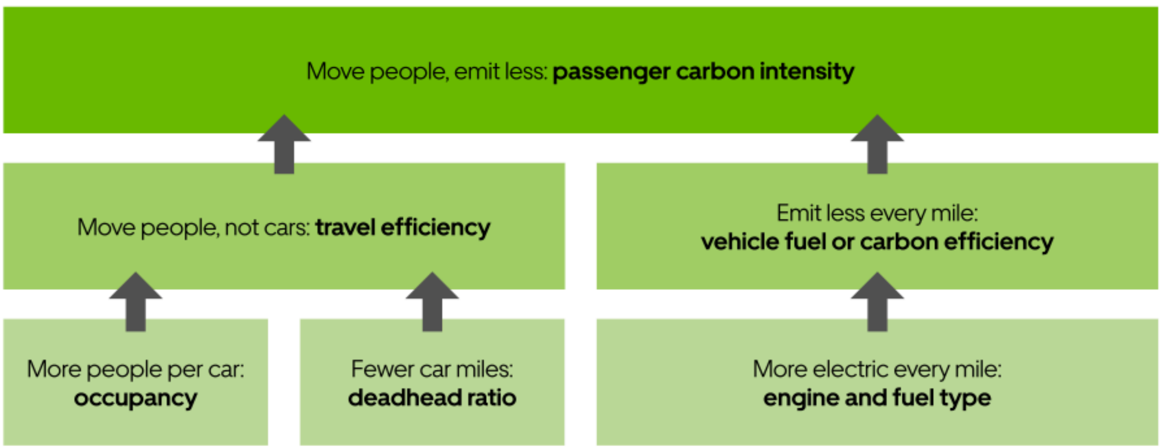
The following formula is used to estimate carbon intensity:

$$CI = \sum_{s,t} \left(\frac{emission_s}{distance_t * occupancy_t} \right)$$

Where:

- CI is carbon intensity in gCO_2 emitted per passenger distance traveled
- $emission$ is CO_2 emissions per driver state s, in gCO_2
- $distance$ is on-trip distance per trip t, in a distance unit (mile or kilometer)
- $occupancy$ is the estimated number of passengers per trip t

The underlying 3 factors that affect carbon intensity are occupancy, deadhead ratio, and engine and fuel type. Here is the outline of this relationship:



For more information, please see our blog posts on carbon intensity and travel efficiency.

Note: We use the term "zero-emission vehicle" (ZEV) the same way the California Air Resources Board (CARB) and Europe's Transport & Environment (T&E) do: to refer to vehicles that produce no direct CO_2 emissions or other criteria air pollutants (such as NOx, particulate matter, CO, and SOx) from the on-board source of power. Regional variations should be considered at the reader's discretion. Drivers on Uber's platform use 2 types of ZEVs today: battery-electric vehicles (battery EVs, or BEVs) and, very occasionally, hydrogen-powered fuel cell electric vehicles (FCEVs). Of course, the "zero" in ZEV refers to no emissions from the proverbial "tailpipe" of the vehicle and not necessarily all the emissions that can be accounted for from production to disposal of the vehicle and its energy source. All accounted for, however, life-cycle analyses by independent experts show that "emissions over the lifetime of average medium-size battery EVs registered today are already lower than comparable gasoline cars by 66%–69% in Europe, 60%–68% in the United States, 37%–45% in China, and 19%–34% in India."