Problems Faced with Replacing Private Vehicles with Ride Hailing

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Introduction

Throughout the last two decades there has been significant evolution throughout the field of technology. The popularity and complexity of cell phones and other technology has changed drastically. The rise of ride sharing apps like Uber and Lyft, has pushed the idea of ride hailing and car sharing over personal vehicle possession. Instead of having a vehicle sitting inactive in a paid parking spot or carport, consumers liked to diminish expenses as well as the environmental effect and embrace the accommodation of shared mobility choices.

Shared mobility, such as car sharing and ride hailing, has become one of the most popular alternatives to private vehicle ownership. Shared transportation has increased enormously within the last 15 years because of reestablished interest in urbanism and developing environmental, energy, and economic worries increasing the requirement for supportable other options. All the while, propels in electronic and remote advances made sharing resources—and information—simpler and more efficient. However, there are many problems associated with shared mobility: CO_2 emissions, energy and gasoline consumption, user dissatisfaction, and traffic congestion.

Background

Vehicles cause a great deal of harm to the environment. They produce huge loads of harmful toxins and synthetic substances that result in greenhouse gas emissions, climate change, and huge water and air pollution. While it would not be feasible to fully leave vehicles as a method for transportation, there are approaches to at least limit the harm to the environment. Ride hailing presents a chance to work on the current environmental circumstances.

Shared mobility models have been closely related to solving traffic problems. In a 2018 review, Georgina Santos divides all emerging shared mobility models into four different kinds: peer to peer provision, short term rental, sign up ordinary car owners as drivers, and shared private cars or other vehicles by passengers going in the same direction. The review concluded that only the model for sharing private cars by passengers going in the same direction could effectively reduce the congestion and carbon dioxide emissions.

The use of electric vehicles, including in ride-hailing services, is expected to have substantial emission reduction benefits. However, these benefits depend on the energy fuel mix in the grid and vehicle usage. Public awareness and education have consistently been some of the biggest barriers to an EV market transformation.

Image 1. CO2 Animation

Objectives

- Using a wide variety of methodologies and assumptions, this study will investigate the impact that changing electric vehicles to light duty vehicles, and private vehicles to ride hailing vehicles has on greenhouse gas emissions.
- Monitor the amount of greenhouse gas emissions, from 2018 to 2035.
- Analyze and construct assumptions based on the modeling simulation.

Methodology

Simulation for prediction on further 2018-2035 datas on energy consumption is performed by the industrial simulation software Vensim, and Microsoft Excel. The model is constructed based on four coflows, the private Light Duty Vehicle, the ride hailing Light duty vehicle, the private electric vehicle, and the ride hailing light duty vehicle. All the four flows are constructed based on the data in table 1.

total gas		total ridesha	total registered car	private electric	shared electric
17382672	17611623.1	228951.1	17726847.61	113726.5908	1497.918623
16281230	16495673.8	214443.759	16603597.14	106520.3775	1403.003958
15183827	15383816.6	199989.616	15484465.64	99340.58933	1308.437347
13876300	14059067.9	182767.882	14151049.71	90786.05939	1195.7637
11968555	12126195.5	157640.542	12205531.5	78304.58732	1031.367411

% of Ride hailing to total car registered	1.30%	
new car sales annual	3,000,000	
% of new sales or ride hailing to total new sales	1.30%	
% of vehicles electric	0.65%	
CO2-eq per kwh	0.0007	Metric tons
CO2-eq per kwh	0.009	metric tons

Table 1. Data and constant used in models

The assumptions are made that no significant event happened during the time range of this modelling simulation. Also, every scrapped vehicle is assumed to be new car sales. Electric Vehicle efficiency is assumed to be stable during simulation period. By using the ideas of coflow for age groups, the coflow is created by vensim as Figure 1.

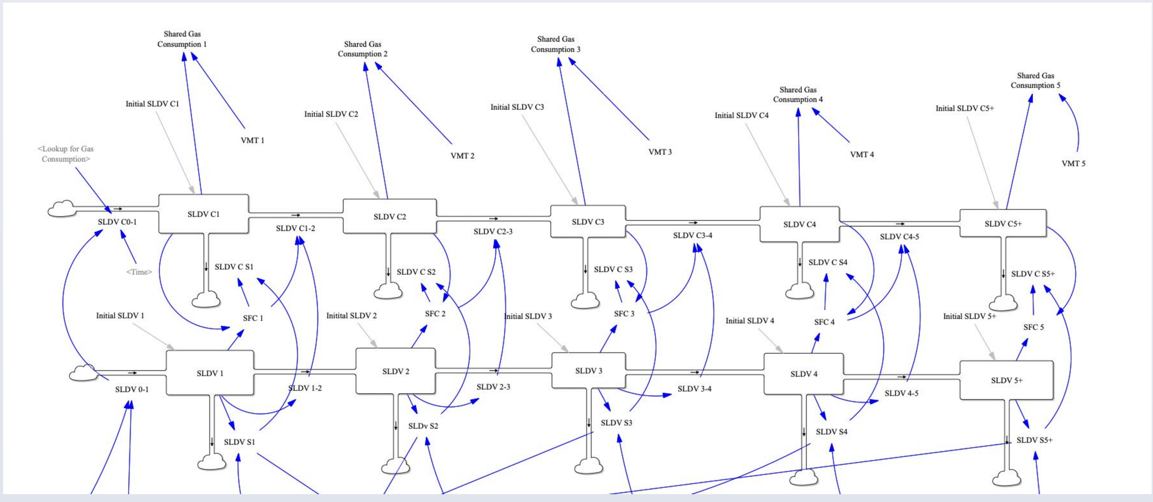

Figure 1. Model for Shared Light Duty Vehicle Coflow (SLDV)

As graph 2 shown, the stock of Shared Light Duty Vehicles are divided into five age stocks (SLDV1, SLDV2, SLDV3, SLDV4, and SLDV5+). Like Shared Light Duty Vehicle, all other three types of stock are constructed based on those ageing from 1 to 5+. Vehicle may move into the next age group once it goes through next year, and it may be scrapped during that year. The outflow for vehicle stock, SLDV S1 and so on, represents the amount of scrapped vehicles during that age group. By introducing Average Fuel consumption rate (SFC) in the model, the related fuel consumption could be calculated by the correlated flows times the average Fuel consumption rate based on equation (1).

$$SFC = \frac{SLDV\ C}{SLDV} \text{ --- } (1)$$

Meanwhile, the gallons of gasoline consumption could be calculated by equation (2):

$$Number\ of\ Gallons = VMT \times SLDV\ C \text{ -- } (2)$$

VMT represents traveled miles per vehicle for gas cars, and SLDV C represents the shared Light Duty Vehicle gas consumption.

In the start of flow, the new shared Light Duty Vehicle each year is calculated based on the equation (3):

$$SLDV\ 0-1 = total\ Shared\ Vehicle \times (1 - Electric\ vehicle\ percentage) \text{ -- } (3)$$

The CO2-eq, which is defined as the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas, is the main variable to be analyzed as the greenhouse gas emissions. By using the equation (4):

total CO2eq for SLDV =total Gallons Consumption of SLDV CO2eq per gallon of gas ----(4)

By using same methodology as SLDV, the private LDV, private Electric vehicle, and ride hailing electric vehicle are set up through vensim simultaneously.

$$total\ CO2eq\ for\ SLDV = total\ Gallons\ Consumption\ of\ SLDV \times CO2eq\ per\ gallon\ of\ gas \text{ -- } (4)$$

Simulation Results and Scenario Analysis

- **Scenario 1**: The percentage of individual using electric and light duty vehicles will remain the same as reference mode (rate is shown in Table1.) The simulation result is shown as Figure 3.

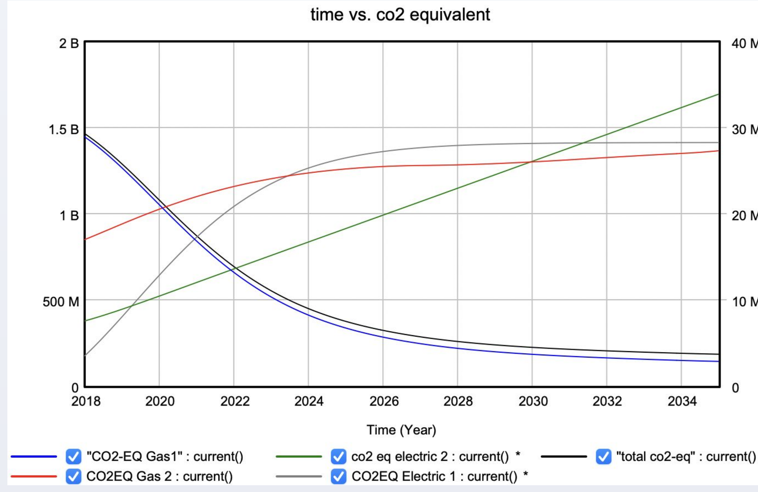

Figure 3. CO2-eq vs. time graph for simulation from 2018 to 2035.

Co2-eq Gas1 represents the CO2-eq emitted from gas consumption for private LDV. CO2-eq Gas 2 represents the CO2-eq emitted from the part of shared Light Duty Vehicle Gas consumption. CO2-eq Electric 1 represents the CO2-eq emitted from electric consumption of private vehicle. And CO2-eq electric 2 represents the CO2-eq emitted from electric consumption of ride hailing.

Inside Figure 3, the CO2-eq is generally decreasing in a rapid rate between 2018-2022. The phenomenon occurs based on the fact that the CO2-eq Gas1 is decreased rapidly as the fuel economy increases and the amount of private LDV decreases. However, since in the reference mode, the rate of electric vehicle and ride hailing is relatively low, the total co2-eq in the system is having a similar behaviour as CO2-eq Gas 1.

- **Scenario 2:** 50% of people will be using riding hailing services over private vehicles. The simulation result is shown as Figure 4.

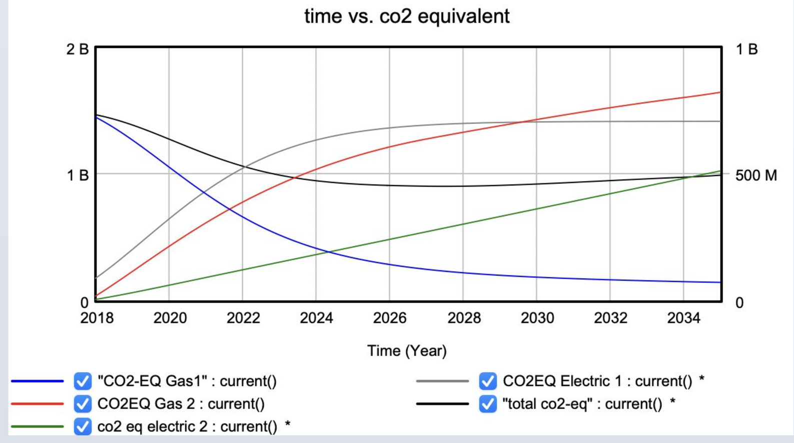

Figure 4. Scenario 2 CO2-eq vs. time graph for simulation from 2018 to 2035.

As figure 4 shows, in the case of 50% people will choose ride hailing services, the CO2-eq is increasing a lot throughout the simulation in contrast to figure 3. Since assumption of constant total vehicle is made in this simulation, the more percentage on ride hailing means an increasing number of vehicles are having more traveled miles. Therefore, it will increase the Co2-eq in general.

- **Scenario 3:** 50% of people will be using riding hailing services over private vehicles, meanwhile, 50% of people will be using electric vehicle. The simulation result is shown as Figure 5.

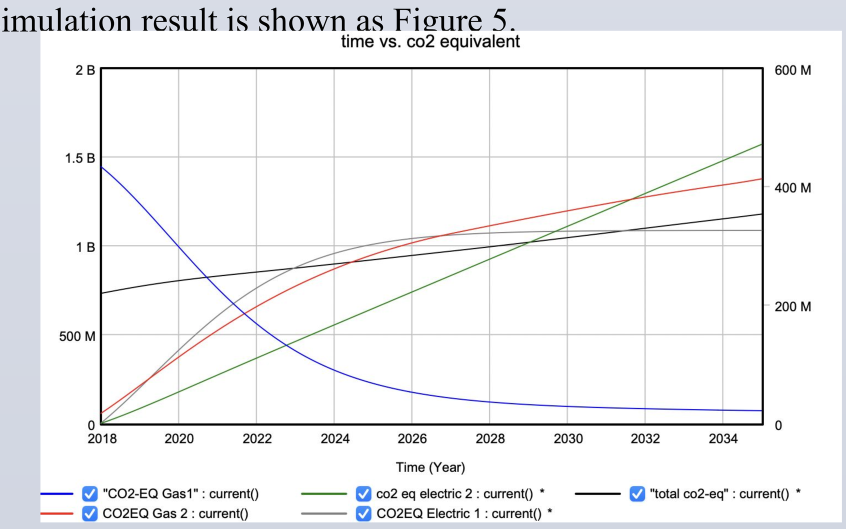

Figure 5. Scenario 3. CO2-eq vs. time graph for simulation from 2018 to 2035

As figure 5 shows, in the case of both 50% of people choosing ride hailing and 50% of people choosing electric vehicle, the CO2-eq is increasing at first. However, due to the traits of electric vehicles generated less CO2-eq, the total CO2-eq is ending with lower value in contrast to Scenario 2.

Conclusion and further improvement

Based on simulation, the electric vehicle is showing a strong effect on reducing the greenhouse gas emissions, whereas the ride hailing is not that effective to reducing the greenhouse gas emission. However, this experiment may face some shortcomings that it doesn't include the simulation on total vehicles constructed. Instead of doing regression analysis on new vehicles produced every year, the assumption, that total amount of vehicles is the part of remaining the scrapped car returning back, is made in simulation. Through this assumption, this may lead to overlook the effect of ride hailing to greenhouse gas emissions, since it should be the case that increasing the amountr of ride hailing would decrease the number of private LDV portion inside the total amount of vehicles.

Meanwhile, further studies are needed to analyze the effect on ride hailing services and the vehicle construction line. These are the factors that can't be ignored in this system.

Ride hailing services and electric vehicles are both alternative to driving one's own car, and these have both personal and environmental benefits. These services can help reduce congestion on the roads when passengers are sharing vehicles going in the same direction, which also reduces CO_2 emissions. CO_2 emissions are largely caused by transportation and private LDV are a factor. The shift to shared mobility services or electric vehicle is better for the environment, but it is not preferred by many commuters. Those who had used these services expressed that they would rather make use of their personal vehicles, due to comfort and privacy. Despite this, the shared mobility industry will still continue to grow as the demand for travel continues to increase.

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