



Evaluating the Impact of Clean Miles Standard on the Transportation system: A Microscopic Simulation in San Francisco

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Project Objective

This research investigates the potential benefits and impacts of the electrified Transportation Network Company (TNC) fleet at system level with the enforcement of Clean Miles Standard in California. TNC dispatching and charging policies and strategies were modeled in microscopic simulation to evaluate the mobility and environmental performance of the TNC system under various EV penetration rates.

Problem Statement

Transportation activity has been consistently contributing to a significant impact on mobility and environment. In California, the transportation sector accounted for about 50% of greenhouse gas (GHG) emissions when accounting for fuel production, and 70% of the transportation-related emissions comes from light-duty vehicles. To collectively decarbonize the transportation sector, Electric vehicles (EVs) are gaining unprecedented popularity recently due to the low greenhouse gas emissions and zero tail-pipe pollutants characteristics. On the other hand, due to the high accumulated driving mileage on the ride-hailing services, electrifying a ride-hailing vehicles enables triple emission reduction compared to electrifying a passenger vehicle. As directed by Senate Bill (SB) 1014, the California Air Resources Board (ARB) developed the Clean Miles Standard and Incentive Program, as a first-of-its kind regulation designed to reduce GHG emissions from TNC vehicles and increase the use of zero-emission vehicles (ZEV). The primary requirements of the Clean Miles Standard are to increase the percentage of total miles driven by TNC using ZEVs, and to reduce GHG emissions per passenger miles traveled.

Research Methodology

A comprehensive simulation framework was proposed in Figure 1 to simulate the transitioning process with TNC electrifying process by gradually increasing EVs penetration rate in the TNC fleet. A microscopic traffic simulator, SUMO, was used to construct the simulation platform and experiments with different scenario setup. The ride-hailing data from San Francisco was integrated into the simulations to quantitatively study the mobility, charging demand, and emission impact changes given the penetration of EVs. Along with the vehicle dispatching policy without considering the vehicle heterogeneity in the fleet, we also tested an eco-friendly ride-hailing dispatching policy where EVs are prioritized to operate during the off-peak hour.

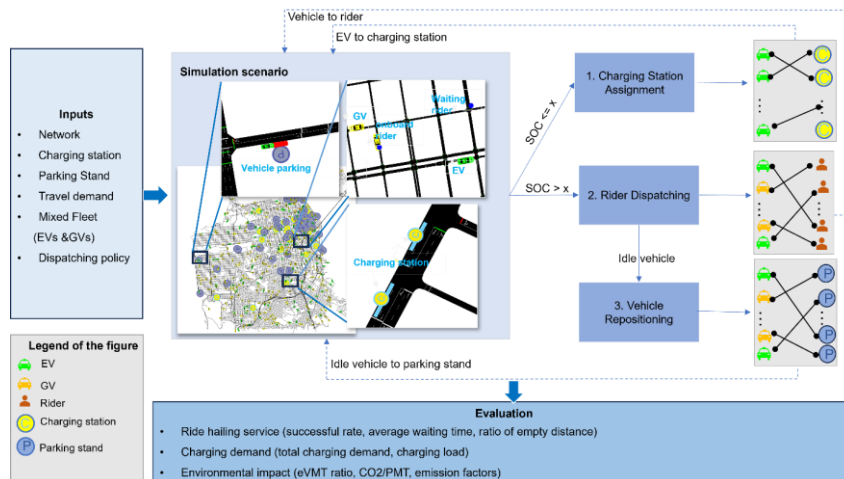


Figure 1 TNC mixed fleet management framework

Results

Experiment results showed that the mobility performance in terms of empty distance and rider average waiting time increase slowly with higher EV ratio in the mixed fleet (see Figure 2). This is due to the increasing EVs charging demand and charging down time. The off-peak EV priority policy depends on a larger EV fleet size to sustain the TNC service effectively. When EV ratio is lower than 40%, it is undesirable to force the off-peak EV priority policy due to higher portions of long waiting and deadheading distance. Secondly, the charging demand steadily increases with higher EV ratio in the mixed fleet. The off-peak EV priority policy has higher charging loads compared to the baseline policy, because the TNC platform utilize EVs to serve more riders. However, the peak charging hour in the off-peak EV priority policy occurs before 6 pm in the afternoon, which results in reduced marginal CO2 emissions during daytime hours and enables the fleet to be adequately prepared for the evening peak in ride-hailing requests.

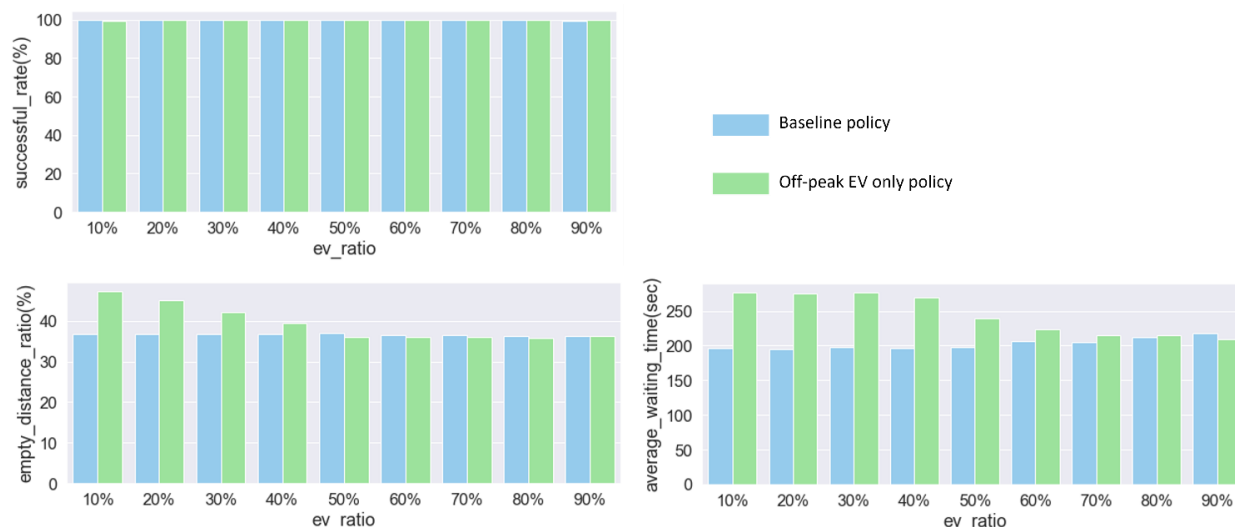


Figure 2 Mobility performance under different EV ratios and different dispatching policies

The evaluation of CMS compliance reveals that the eVMT target is easier to achieve compared with the GHG target. The off-peak EV priority policy shows superiority in saving an extra 30% of CO2 compared to the baseline policy when EV penetration is at 50%. In summary, to comply with CMS, the TNC platforms should encourage more EV participation in the ride-hailing service, and deploy an eco-friendly dispatching policy to increase EV utilization and ride pooling.

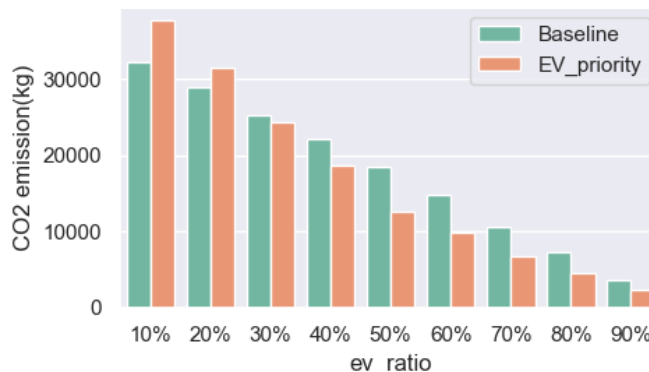


Figure 3 Total CO2 emissions of mixed fleet under different policies

According to the sensitivity analysis, the repositioning strategy has less impact on the rider average waiting time. This can be attributed to San Francisco's dense ride-hailing demand pattern, where even without active repositioning, drivers efficiently serve riders due to the concentrated demand in various areas. With higher home charge access, TNC drivers can serve the ride-hailing trips with limited public charging demand. These findings underscore the critical need for stakeholders to consider home charge access when planning and constructing charging infrastructure.