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Fleet performance and cost evaluation of a shared autonomous electric vehicle (SAEV) fleet: A case study for Austin, Texas

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Highlights

- Agent-based simulation of shared autonomous electric vehicles (SAEVs) in Austin, Texas.
- Includes dynamic ridesharing, SAV rejection model, and charging station simulation.

- Reliance on fully electric vehicles appears less profitable than using hybrid-electric vehicles.
- Fast-charging and long-range capabilities are useful SAEV investments.
- Each shared AV may replace 6 to 10 privately owned conventional vehicles.

Abstract

Shared Autonomous Vehicles (SAVs) have gained significant public interest as a possible less expensive, safer and more efficient version of today's transportation networking companies (TNCs) and taxis. One way to expand on the possible benefits of an SAV fleet is through electric vehicles (EVs), which tend to be more energy efficient, more reliable, quicker, and may reduce system-wide emissions when coupled with renewable power. EVs are quickly becoming more financially viable as the price of these vehicles drops and charging infrastructure is appearing in more and more locations across the world. EVs are disadvantaged by their relatively short range and long recharge times, so it is important to understand how these factors will affect an electrified SAV (SAEV) fleet in terms of vehicle miles traveled (VMT), vehicle productivity, and response times.

Perhaps the most important factor to consider before implementation is cost, since it is quite unlikely that a fleet operator will elect to use an EV fleet when a gasoline fleet is more profitable. This study makes in-depth estimates of the cost of this SAEV fleet based on vehicle purchasing costs, vehicle maintenance, batteries, electricity, charger construction (including land acquisition and paving), charger maintenance, insurance, registration and general administrative costs. These costs are estimated at low-, high- and mid-cost scenarios, where mid-cost is the most expected.

This study performed a simulation of SAEVs across the Austin, Texas 6-county region under 6 different fleet scenarios to assess what factors make the fleet the most profitable and provide the best customer experience. The simulation process features thoughtful charging strategies, dynamic ridesharing, mode choice, and a multi-step search algorithm. Results showed that for all metrics studied, the gasoline hybrid-electric (HEV) fleet performed better than EV fleets, while remaining more profitable, providing response times of 4.5 min compared to 5.5 min. The HEV fleet is the more profitable option until the cost of gasoline exceeds $10 per gallon or the cost of a long-range EV falls below $16,000 through subsidies. Of all the EVs studied, the long-range fast-charging scenario not only provides the best service in terms of all metrics studied, but is by far the most profitable. Even though EVs may not be financially advantageous in the near term, the environmental benefits could be substantial; EVs have the potential to provide zero-carbon transportation when coupled with a renewable power grid. Gasoline vehicles have no such

potential. Environmentalism tends to have little effect on financial decisions, but a carbon tax could change that perspective.

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