Shared Autonomous Electric Mobility: Opportunities & Challenges

T. Donna Chen
Department of Engineering Systems & Environment
University of Virginia
tdchen@virginia.edu

The growth of the sharing economy, combined with the rapid development of self-driving and electric vehicle technology presents new opportunities and challenges for urban transportation. Share autonomous electric mobility holds great promise for transforming urban land use (in an on-demand carsharing platform with decreased parking infrastructure), alleviating congestion (in a dynamic ridesharing platform with increased vehicle occupancy), and increasing access to rapid public transit (as a first/last-mile connection service). Carsharing provides access to automobiles without incurring capital and maintenance expenses associated with vehicle ownership. For low-mileage travelers, carsharing provides a lower-cost alternative to owning a private vehicle but provides more flexibility than transit service. However, carsharing operations are likely to induce imbalances in the spatial and temporal vehicle distribution that requires relocation operations to maximize vehicle availability. Hence, the management of such operations becomes complicated due to demand characteristics, imbalance issues, operational constraints, and the need to maximize the use of carsharing systems

This talk will introduce discrete-time and real-time agent-based models that have simulated fleet performance of Shared Autonomoous Electric Vehicles (SAEVs) as 1) a replacement mode for single-occupant privately-owned manually-driven vehicles, 2) an on-demand dynamic multi-occupant ridesharing system, and 3) a complementary feeder service for station-based transit. Case studies using travel data from Austin and Seattle demonstrate performance metrics such as percent of trip demand met, average passenger wait times, total fleet vehicle miles traveled, and necessary fleet size. The talk will lend insight into the competition and complementarity between SAEVs and traditional public transit modes. Scenario analysis evaluate the effect of electric vehicle range and recharge time on fleet performance in each use case, and the cost tradeoffs between additional investments in larger battery vehicles and faster recharging infrastructure and service metrics.

As shared autonomous electric vehicle (SAEV) fleets roll out to the market, the electricity consumed by the fleet will have significant impact on energy demand, and will drive variation in energy cost and reliability, especially if the charging is unmanaged. Meanwhile, SAEVs are considered as important assets for the gird, due to its ability to serve as demand management units that are more mobile and controllable comparing to privately-owned EVs. The last part of this talk will highlights some challenges with managing SAEVs when integrated with a smart electricity grid, demonstrating smart charging management under static and real-time pricing schemes as well as with solar generation with a case study from the Puget Sound (Seattle metropolitan) region.