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CITYWIDE MOBILITY-ENERGY ORCHESTRATION: FROM SHARED ELECTRIC VEHICLES TO SELF-SUFFICIENT AND RESILIENT MICROGRIDS

Abstract: Major paradigm shifts are underway in the mobility and energy sectors of our cities. The booms of the sharing economy, electric vehicles (EV), decentralized renewables integration, along with the emergence of autonomous driving, urge us to evaluate the implications of their synergy. Along this direction, we examine two scenarios: (1) In the near-term scenario, we focus on how to charge the EV sharing fleet to make EV sharing viable and profitable. We integrate charging infrastructure planning and vehicle repositioning operations. More interestingly, our modeling emphasizes the operator-controlled charging operations and customers’ EV picking behavior, which are both central to EV sharing but were largely overlooked in the literature. We formulate the integrated model as a nonlinear optimization program with fractional constraints. We then develop both lower- and upper-bound formulations as mixed-integer second order cone programs, which are computationally tractable with small optimality gap. (2) In the long-term scenario, we investigate the potential of operating shared autonomous electric vehicles (SAEVs) for improving the self-sufficiency and resilience of solar-powered urban microgrids. We develop a dynamic network representation of SAEVs. Then we formulate linear program models to incorporate an array of main operational decisions interconnecting the mobility and energy systems. To anticipatively ensure microgrid resilience, we also propose an “N-1” resilience-constrained fleet dispatch problem to cope with microgrid outages, along with an efficient solution algorithm. Calibrated with multiple sources of data of San Diego and New York City, our models and findings demonstrate the promising and rich potential in deepening the integration of urban mobility and energy service systems towards a smart-city future. Follow this link:
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