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Shifting Future Electric Vehicle Trips to e-Bikes Could Help Reduce Electricity Demand at Critical Times in California

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Issue

California aims to replace gasoline and diesel light-duty vehicles (LDVs) with zero-emission LDVs, many of which will be plug-in battery electric vehicles (BEVs) and achieve 100% zero-carbon electricity by 2045. Large-scale plug-in BEV deployment will substantially increase electricity demand, particularly during peak hours (4:00pm to 9:00pm) when renewable energy is in short supply. Popular strategies for charging BEVs with electricity produced from renewable energy include smart charging and creating more energy storage that soaks up renewable energy during the day and dispenses it later when needed. These strategies, however, may not be enough. Consumer acceptance limits smart charging, and increased energy storage capacity is expensive. Another potential strategy involves lowering the overall demand for electricity by shifting BEV trips to electric-powered bicycles (e-bikes). While e-bikes cannot entirely replace BEV trips, they are ideal for short trips (five miles or less). Currently, 64% of US vehicle trips fall into the short trip category.

Using synthetic travel pattern data from the San Diego region, we quantified the electric grid cost savings of shifting future BEV trips to e-bikes. For our analysis, we determined the passenger LDV trips that e-bikes could potentially replace. To provide an upper bound on replaceable trips, we considered trips that met the following criteria: LDV trips within home-based tours (a sequence of trips starting and ending at the home location) made by no more than two household members (between 16 and 70 years old), with less than five stops, under four hours in travel duration, and with individual trip distances up to seven miles long. We also created three scenarios that differ in terms of the tour purposes:

- Scenario 1: All purposes (e.g., work, recreation, eating out, etc.) except escort (i.e., transporting someone else to their activity) and shopping tours
- Scenario 2: All purposes except escort tours
- Scenario 3: All purposes

Key Research Findings

Substituting BEV trips with e-bikes can decrease peak electric demands. If we assume all passenger LDV trips are made by BEVs in the no-e-bikes scenario, then converting 20% of these trips to e-bikes from Scenario 3 could reduce the electric load from LDVs by up to 30% during peak evening hours when BEVs are typically charged at home. See Figure 1.

Absolute cost savings for shifting short trips from BEVs to e-bikes is substantial, even if the percentage cost savings are small. With e-bikes substituting for BEVs, California could save up to 0.9% on wholesale electricity system costs by 2030 and 1.4% by 2045. The percentage savings are small

even in 2045 because BEVs represent roughly 10% of the annual electric load, and (as mentioned previously) e-bikes can only displace roughly 20% of that load at most. Still, this represents savings of approximately $225 million annually by 2030 and $460 million annually by 2045.

Based on current travel patterns in San Diego, shifting short trips to e-bikes would have an underwhelming impact on reducing overall vehicle miles traveled (VMT). Under Scenario 3 (e-bikes replace all tour purposes), e-bikes could potentially replace 44% of current vehicle trips in San Diego. However, even if e-bikes replaced every single one of these vehicle trips, VMT would only decrease by 20% because a large majority of VMT occurs on trips longer than seven miles.

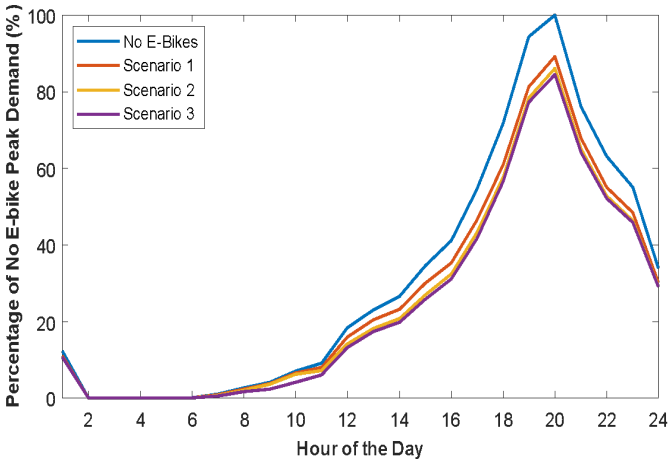

Figure 1. Percentage of No E-Bike Peak Demand throughout the hours of the day, based on different scenarios

Conclusion

The government has mechanisms to shift travelers from LDVs to e-bikes, including (i) investing in bike infrastructure, (ii) subsidizing e-bikes, (iii) incentivizing employers to increase employee e-bike usage, and (iv) promoting mixed-use, infill, and transit-oriented developments, which will likely reduce length of trips and make e-bike trips more feasible. The efficacy of using these mechanisms to shift travelers from BEVs to e-bikes depends on (i) their costs, (ii) their effectiveness in terms of shifting travelers, and (iii) the benefits of shifting travelers. Existing studies quantify the health, environmental, and mobility benefits of shifting trips from LDVs to e-bikes. Our study measures another benefit—electric grid cost savings. We find that the potential cost savings in California are substantial--$460 million per year by 2045. Policy analysts should consider this benefit alongside others in their cost-benefit analyses of mechanisms to shift trips from LDVs to e-bikes.

More Information

This policy brief is drawn from a forthcoming journal article to be posted on the research project's webpage at www.ucits.org/research-project/2023-40. For more information about the findings presented in this brief, please contact Mike Hyland at hylandm@uci.edu.

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