Title

Dynamic Wireless Charging Lanes for Electric Drayage Trucks

Author

Wei, Ran, PhD

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POLICY BRIEF

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Are Dynamic Wireless Charging Lanes for Electric Drayage Trucks a Viable Option for California?

Ran Wei, Ph.D.
School of Public Policy, University of California, Riverside

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Issue

State regulations require all drayage trucks transporting containers and bulk goods to and from seaports and intermodal railyards to be zero-emission by 2035, and starting in 2024 trucks registered with the California Air Resources Board (to begin or continue operations at a California seaport or intermodal railyard) must be zero-emission.[1] Converting these trucks to electric power is a promising pathway, and Dynamic Wireless Charging Lanes (DWCLs) could serve as a powerful supplement to traditional stationary charging stations. With recent advancements, Class 8 trucks (the heaviest class of trucks) can achieve a charging power of 175kW from DWCLs. From another perspective, a 20-minute traffic delay while traveling in a DWCL can provide a truck with 30 miles of extended range. While not widely deployed today, there are several completed and active DWCL demonstration projects, including a recent one-mile pilot project in Detroit, Michigan, marking the first such program on a U.S. public road.[2] There have also been various European DWCL demonstration projects as well.[3]

To better understand DWCL applications in California, we developed a hypothetical case study of DWCL deployment for drayage trucks on a highway network of more than 1,000 miles around the Greater Los Angeles area, home to two of the world's busiest seaports, the Port of Los Angeles and the Port of Long Beach. We identified optimal locations for DWCLs to serve drayage trucks efficiently along with consideration of suitable grid connection and upgrades of existing power grid to meet heightened energy demand.[3]

Key Research Findings

The I-710 corridor near the San Pedro Bay port area is ideal for initial DWCL deployment. The most beneficial starting point for DWCL deployment is along the I-710 corridor near the Ports of Los Angeles and Long Beach, due to the density of drayage trucks and the availability of nearby substations. Based on our analysis, deployment along the I-110, despite its proximity to the ports, should be delayed to a later phase due to a lack of electric substations in that area. Further expansion could extend north and east from the port, along I-605, State Route (SR) 91, and SR 60, towards the clusters of warehouses in the Inland Empire.

The annualized cost of slightly over $500,000 per mile represents a cost-effective investment. Our study indicates the annualized cost per mile, including construction, charging equipment, and power system expenses, is estimated at $580,000 to $620,000 annually over a 25-year lifespan. However, the added congestion costs from speed reductions due to lane closures during construction could limit the geographical expansion of DWCLs and affect the annual electricity supplied. These should be considered in developing the final system (see Figure 1).

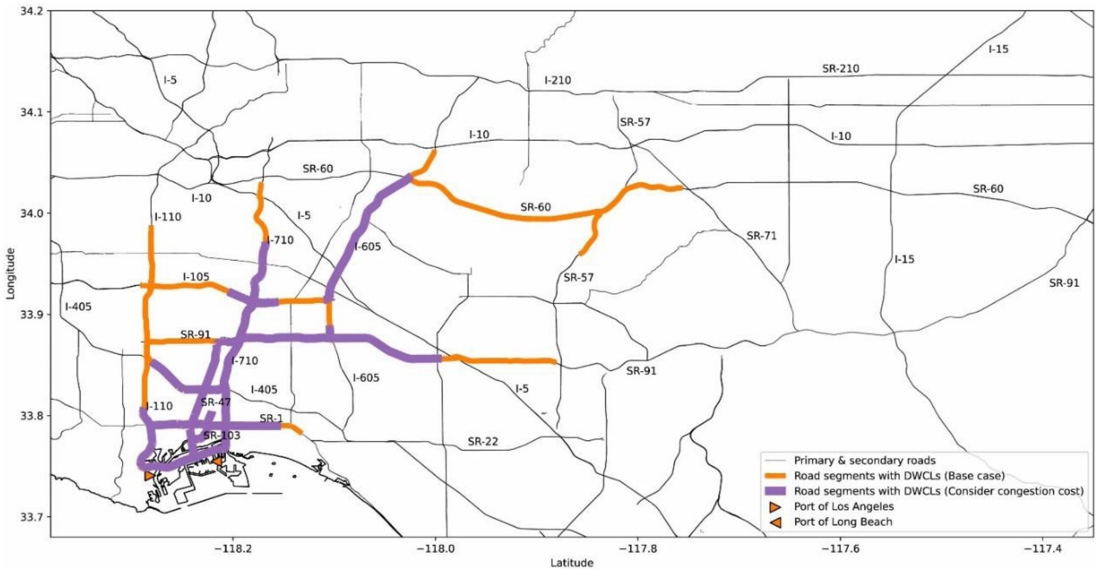

Figure 1. Location of of DWCLs with a $200 million annual budget: Base case (orange) and congestion cost (purple) consideration.

A two megawatt per mile power capacity for DWCLs optimally balances efficiency and cost. Balancing capacity and investment are crucial. While higher capacities enable more trucks to charge simultaneously, it also demands greater investment in power system upgrades. Our study identifies two megawatts per mile as the optimal power capacity, striking a favorable cost-benefit balance compared to one megawatt or four megawatts per mile alternatives.

The deployment of DWCLs and the subsequent electrification of drayage trucks would contribute to both immediate mitigation of urban air pollution and long-term decarbonization goals. This would be especially important in disadvantaged communities, where heavy-duty trucks are a major source of air pollution and health risks. Furthermore, in places like California where there is extensive daytime solar power generation, DWCLs can help electric drayage trucks absorb excess "green" electricity and function as "moving batteries" during their operations, thereby saving the costs needed for stationary energy storage.

More Information

This policy brief is drawn from the journal article Joint Planning of Dynamic Wireless Charging Lanes and Power Delivery Infrastructure for Heavy-Duty Drayage Trucks, available at www.ucits.org/research-project/2023-16. For more information about the findings presented in this brief, please contact Ran Wei at ran.wei@ucr.edu.

[1]California Air Resources Board Advanced Clean Fleets Regulation (ACF). This regulation implements the Governor's Executive Order N-79-20, 2020.

[2]Buchholz, K. Wireless road charging for EVs to debut in 2023 [online], SAE International, 2022, https://www.sae.org/news/2022/06/wireless-road-charging-for-evs.

[3]Konstantinou, T., Haddad, D., Prasad, A., Wright, E., Gkritza, K., Aliprantis, D., Pekarek, S., Haddock, J. E., et al. Feasibility study and design of in-road electric vehicle charging technologies (West Lafayette: Purdue University, Joint Transportation Research Program, 2021).

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