Title
New UC Davis Model Shows Promise in Identifying Optimal Locations of Hydrogen Refueling Stations for Medium- and Heavy-Duty Trucks in California

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New UC Davis Model Shows Promise in Identifying Optimal Locations of Hydrogen Refueling Stations for Medium- and Heavy-Duty Trucks in California

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Issue

California's Advanced Clean Trucks regulation is designed to reduce freight-sector greenhouse gas emissions. It will require automakers to introduce zero-emission medium- and heavy-duty trucks starting in 2024. Trucks using hydrogen fuel cell technology would meet the requirements of the regulation and have several advantages over their battery-electric counterparts due to their longer driving range and shorter refueling time. However, a lack of sufficient refueling infrastructure is a key barrier to adoption. Few truck-oriented hydrogen refueling stations exist in California, but the state is providing funding for additional fueling infrastructure. Identifying the optimal number, size, and locations of hydrogen stations could assist investors in the deployment of this infrastructure and provide valuable information for electric grid planners. Doing so will depend on understanding the number of vehicles on the road, travel patterns, refueling patterns, and refueling station needs.

Researchers at UC Davis developed "Spatial Transportation Infrastructure, Energy, Vehicles, and Emissions (STIEVE)," an optimization model for hydrogen refueling stations in California. The model uses inputs from the California Statewide Travel Demand Model (CSTDM) and other sources to determine heavy-duty vehicle travel demand across the state, and the corresponding, localized energy demand. The model then determines which of the transportation analysis zones (areas based on census geography used to replicate areas of trip origins and destinations) delineated by the CSTDM are optimal areas for refueling stations and the number of stations needed in each zone to meet demand while minimizing costs. The final step is a suitability analysis that identifies each station's specific location within a designated transportation analysis zone, based on a determined footprint for the refueling station.

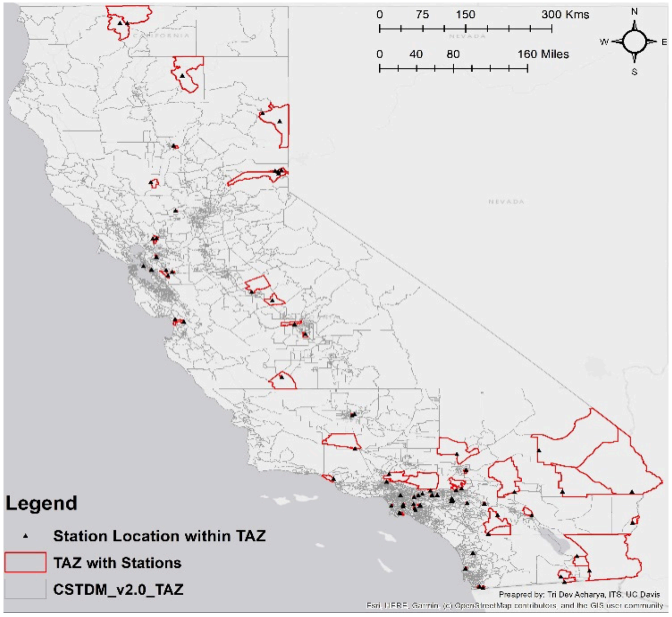

Figure 1. An early modeling result depicting the optimal transportation analysis zones (TAZs) for locating refueling stations to meet the hydrogen demand of long-distance, heavy duty trucks, when 50% of them are fuel-cell vehicles.

Key Research Findings

The hydrogen station optimization model is designed to capture large-scale transportation systems at very high spatial resolution. The model achieves this by aggregating travel demand between common origins and destinations rather than tracking individual vehicles, which would typically be necessary for high spatial resolution. This means

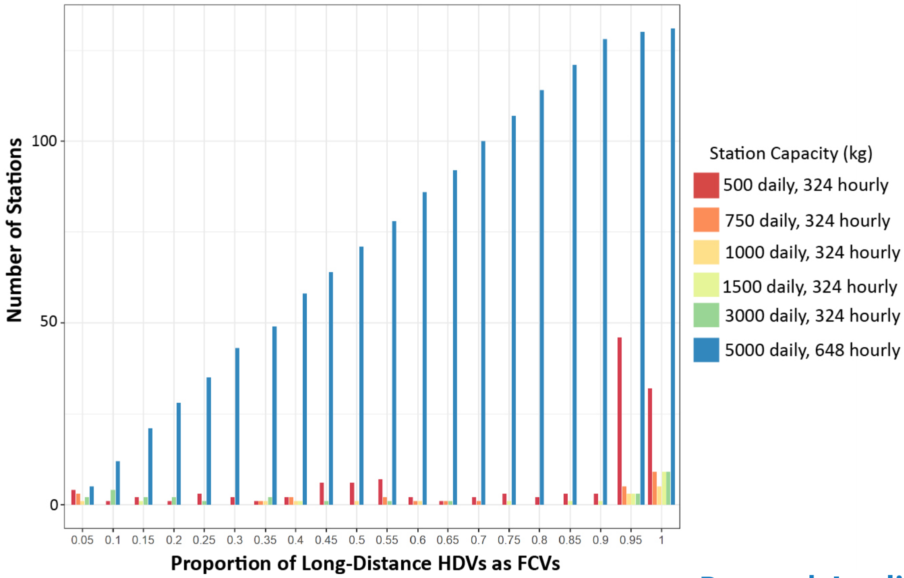

Figure 2. An early modeling result depicting the optimal number and capacity of hydrogen refueling stations in California as the fleet of heavy-duty fuel cell trucks grows (HDV, heavy-duty vehicles; FCV, fuel-cell vehicles).

that the model can be used for any level of hydrogen truck adoption without increasing the computational complexity of the system, which is useful for exploring a broad array of adoption scenarios.

For a scenario in which 50% of long-haul trucking shifts to hydrogen, the current results of the model identify 78 optimal locations for hydrogen refueling stations across the state. (Figure 1). These stations are spread across 71 transportation analysis zones around the state. Optimal station locations tend to be at the intersection of multiple road networks, near major cities, and along California's borders.

The results of the modeling to date show that most hydrogen refueling stations for the trucking sector will need to have large capacities. Optimization runs of the model focused on longer-distance hydrogen trucking and showed that, after provision of some smaller stations in the early stages of deployment, station size shifts to the maximum allowable under the model (a capacity of five tons per day) in order to meet the expected demand from a growing fuel cell vehicle fleet. Once hydrogen trucks begin reaching saturation in the fleet, some smaller stations will again be needed to fill in final gaps in the system (Figure 2).

Research Implications

The current spatial model should be considered an early version, and the results presented in this brief are an initial set of runs using travel data only for heavy-duty vehicles. The model is being refined to incorporate light- and medium-duty vehicle travel, energy distribution infrastructure availability, opportunities for integration with the electric vehicle charging network, and land parcel size limitations for specific hydrogen refueling station locations. Once further refined, the model can serve as an important tool for informing investments in hydrogen infrastructure. The hydrogen demand generated by this model can also be used as inputs in other models, such as hydrogen supply models currently under development.

More Information

This policy brief is drawn from the report, "Spatial Modeling of Future Light- and Heavy-Duty Vehicle Travel and Refueling Patterns in California" prepared by Tri D. Acharya, Alan T. Jenn, Marshall R. Miller, and Lew M. Fulton of the University of California, Davis. The full report is available on the UC ITS website at www.ucits.org/research-project/2020-46.

For more information about the findings presented in this brief, please contact Lew Fulton at lmfulton@ucdavis.edu.

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