

Preparing Communities in California for EV-Based Evacuations

Dr. Clotilde Robert ^a, Dr. Sam Markolf ^b, Pr. Ricardo de Castro ^a

^a Department of Mechanical Engineering, University of California, Merced

^b Department of Civil & Environmental Engineering, University of California, Merced

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Issue

California is rapidly expanding its fleet of electric vehicles (EVs) and the charging infrastructure to support them. At the same time, recent studies highlight that climate-driven hazards in California, such as wildfires and extreme heat, are becoming more frequent and disruptive [1]. In the context of these trends, Key questions and issues arise about evacuation readiness and the appropriate number of chargers, as well as how they are distributed, managed, and prioritized during an emergency. Without integrated planning, protocols, and backup strategies, infrastructure may look sufficient on paper but fail under real-world stress. This gap between infrastructure expansion and operational readiness raises concerns about whether counties are truly prepared to support EV-based evacuations during extreme events.

Key Research Findings

*[*Note that main points are bolded with explanatory text following.]*

Educating population to keep high charge levels in EVs during hazards events is crucial.

Our research shows that electric vehicles that have high state of charge (>80%) are able to reach most shelters without needing to stop or accessing charging infrastructure [2]. California's counties are recommended to include communication campaigns to reinforce this crucial recommendation.

Strategic deployment of mobile EV chargers helps decrease evacuation time

We performed a case study in Mariposa County, CA wildfire-driven evacuation conditions with high adoption of EVs. Our results show that even modest deployment of mobile charging stations (MCS) yields significant benefits: adding 25% mobile charging capacity reduced maximum evacuation time by 33% and average wait times by 44%. Benefits arise from a compound effect, where MCS not only expands charging opportunities but also unlocks new routing patterns that improve utilization of fixed charging stations during emergencies [3].

Communities need a “playbook” for deployment of mobile EV chargers

Our consultations with communities partners reveal that some offices of emergency services do not have a clear guidelines for the logistics around mobile EV charging. Two of the critical questions include: i) who is going to finance the acquisition of these resources (local, county vs state)? ii) communities also need MOUs with possible site hosts (e.g. parking lots, public facilities, malls, etc) to deploy these chargers during emergencies.

Local officials need to be aware of the power/energy needs of EVs during emergency evacuations

During emergency evacuation, there may be a surge of power needs at charging stations. Are the communities aware of the energy and power needs during these emergencies? We recommend that local officials use tools (such as [4]) in order to gain understanding of energy/power requirements and identify gaps in the

infrastructure that may emerge during emergencies. Without a clear understanding of energy needs, communities cannot be properly prepared for EV-based evacuations.

Communities need to plan and act to protect disadvantaged groups in EV evacuations.

EV owners without home charging access face significant disadvantages during evacuations. Communities lacking residential charging should be prioritized, with mobile chargers deployed in those areas to ensure equitable access. In this critical location it will be a benefit to add more fixed chargers. In addition, all communication and outreach on EV evacuation should be provided in at least English, Spanish, Chinese, and Hindi: the four most widely spoken languages in California.

Formal agreements and partnerships are essential

Public–private partnerships (P3s) and formal protocols with charging providers are critical to ensure resilience during emergencies. Without such agreements, communities may have infrastructure in place but no assurance it can be accessed or prioritized when needed. Memoranda of Understanding (MOUs) are particularly important; for example, agreements with companies providing MCS to guarantee their timely deployment to the right locations during a disaster.

Communities must receive guidance and resources to manage EV-based evacuations

Currently, counties have very little guidance on how to prepare for evacuations involving electric vehicles [5]. This gap is the reason why our project was launched: to provide communities with practical support through workshops, decision-aid tools, and indicators. A detailed report [6] is now available, offering a framework that counties can use to assess their readiness and identify priority actions for EV-based evacuation planning.

Plan EV-friendly routes and coordinate charging to ensure smooth evacuations

Counties should plan evacuation routes that include charging options and organize departures in staggered groups to avoid congestion. Deploying mobile charging stations (MCS) near key intersections or in areas with limited infrastructure can greatly speed up operations and allow more vehicles to complete their journey safely [3].

Further Reading and More Information

This policy brief is the result of two years of collaborative work among all the researchers cited in the articles listed below, carried out as part of the project *Improving Preparedness of Communities for Evacuations Using Zero-Emission Vehicles*.

For more information about findings presented in this brief, please contact Dr. Sam Markolf at smarkolf@ucmerced.edu and Prof. Ricardo de Castro at rpintodecastro@ucmerced.edu.

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[1] J. E. Keeley and A. D. Syphard, "Climate Change and Future Fire Regimes: Examples from California," *Geosciences*, vol. 6, no. 3, p. 37, Sep. 2016, doi: 10.3390/geosciences6030037.

[2] F. Shuang, "Optimizing Emergency Evacuation Planning of Zero-Emission Vehicles," *Prep.*, 2025.

[3] X. Tang *et al.*, "Enhancing Large-Scale Evacuations of Electric Vehicles Through Integration of Mobile Charging Stations," in *2024 IEEE 27th International Conference on Intelligent Transportation Systems (ITSC)*, Sep. 2024, pp. 1494–1501. doi: 10.1109/ITSC58415.2024.10919547.

- [4] F. ZareAfifi, R. de Castro, and S. Kurtz, "Planning for electric-vehicle evacuations: energy, infrastructure, and storage needs," in *2024 IEEE Vehicle Power and Propulsion Conference (VPPC)*, Oct. 2024, pp. 1–6. doi: 10.1109/VPPC63154.2024.10755447.
- [5] O. Saleem, K. Corzine, L. Parsa, and R. de Castro, "Development of Zero-Emission Vehicle Evacuation Readiness Score Formulation Methodology," in *2024 IEEE 67th International Midwest Symposium on Circuits and Systems (MWSCAS)*, Aug. 2024, pp. 744–748. doi: 10.1109/MWSCAS60917.2024.10658929.
- [6] S. Osman, R. Clotilde, M. Sam, and de C. Ricardo, "Are Your Community Ready to Evacuate with Zero-Emission Vehicles?," University of California Merced, 2025.