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Notes

Planning  
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Project Title:  
Strategic Charging Infrastructure  
Deployment for Electric Vehicles

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## Evaluation of Electric Vehicle Charging Station Deployment

Evaluate and assess charging infrastructure networks for electric vehicles that also involves driving behavior modeling.

### WHAT IS THE NEED?

The transportation sector was accountable for more than 20% of CO2 emissions worldwide and about 30% in the U.S. To reduce greenhouse gas (GHG) emissions, electric vehicles (EVs) are widely discussed as alternatives to conventional internal combustion engine vehicles. Their potential benefits include, but are not limited to, relatively lower operating and maintenance costs, as well as, reduced or no dependence on gasoline. However, without accessible charging infrastructure, it is not possible for drivers to be convinced to adopt EVs. Therefore, strategically locating charging stations with driver behavior considerations is an essential step towards EV mass adoption.

In this study, we attempt to develop a tool that optimizes the design of a network of charging stations. Using this model, we will be able to input data of different regions to determine where the charging stations should be located and estimate the corresponding costs. By varying the inputs of the model, we may perform scenario analysis that sheds light on whether the innovative solution is economical under different conditions.

### WHAT ARE WE DOING?

In this project, we will study how to determine the charging station locations and charger installation with uncertain customer coverage and equivalently uncertain EV adoption rates. Note that instead of formulating a competitive location model by specifically considering competition from conventionally fueled vehicles and their refueling infrastructure in the location decisions, we will consider the competition effects in the modeling of demand. The demand we use in the model will reflex the competition from the conventionally fueled vehicles and even other transportation models (using choice modeling). Our demand model is rather complex as it considers vehicle and trip characteristics, as well as some driving behaviors.



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The proposed project will yield three major documents:

- (1) A summary of the findings from the literature review and fact gathering task, which will provide a better understanding of the overall problem and the factors that would affect the locations of the EV charging stations
- (2) A discussion of the formulation of the model and the development of the solution algorithms
- (3) The project's final report

### WHAT IS OUR GOAL?

The goal is to determine charging station locations and charger installation with uncertain customer coverage and equivalently uncertain EV adoptions, by developing a tool that optimizes the design of a network of charging stations.

### WHAT IS THE BENEFIT?

The benefit will be the development of a model that provides a robust design for the charging station network, and conducting experiments and scenario analysis to test if the charging station solution is economical under different conditions. The results will provide important insights on the sustainability of future transportation systems based on EVs.

Designing a robust charging station network will facilitate the adoption of EVs as the network has to be designed and put in place before the vehicles are introduced in full scale. Widespread use of EVs can have several benefits for California, especially regarding energy usage. For example, by enabling better use of California's energy grid by charging the vehicles during off-peak periods, which results in better utilization of electricity-generating infrastructure, and in the case of the developing smart grid in California, vehicle batteries can be used to store energy at periods of low demand and then fed back to the grid at peak periods, which mitigates the need of peaking plants. Furthermore, electric vehicles will protect California's drivers from volatile gas prices.

### WHAT IS THE PROGRESS TO DATE?

The Principal Investigator (PI), Zuo-Jun Max Shen, completed Task 1, Literature Review and Information Gathering. This included an extensive and in-depth literature review as well as discussions with the PI's industry contacts. The purpose was to better understand the current research status in the areas of EVs, travel behavior modeling, analysis on the impacts of large-scale transportation infrastructure, green transport strategies, and public attitudes toward EVs.

Additionally, the PI visited China in June to spend time interviewing taxi drivers of an all-EV taxi company about their experiences with charging practices and to study the charging infrastructure of Beijing.