

Research Algorithm

Geo-temporal Distribution of Charging Opportunity

- We design a matrix of Charging Opportunity (CO) for any possible location as *People · Dwelling time;*
- Understand the mobility of people, which is the initial demand no matter their travel pattern;
- Can be easily transferred to *Vehicle* · *Dwelling time* with different vehicle occupation rates under different scenarios with shared mobility or/and autonomous vehicle.

Optimized Geospatial EVSE system

- Mixed integer optimization model;
- Consider the temporal and geospatial disparity of electricity, as well as infrastructure;
- Minimize system cost = charging cost + infrastructure cost;
- Optimal locations for EVSE, and charging strategies.

Datasets

- CHTS 2012 DATABASE:
- ✓ 42,431 completed households: 36,714 non-GPS households and 5,717 GPS households;
- Of the GPS households 3,855 were wearable GPS, 422 used in-vehicle GPS only, and 1,440 used in-vehicle GPS plus OBD;
- ✓ Travel dairy datasets offer spatial and temporal information on the mobility of every person in the households (including non-GPS households).

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- California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics:
- Records the location of the EV owners;

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- Aggregate the records into zip code level;
- Adjust the CHTS weights by multiplying the EV ownership rates.

Geospatial Modeling of Electric Vehicles Supply Equipment (EVSE) in California

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Institute of Transportation Studies, University of California, Davis - Sep. 2018



Discussion

- Potential for Fast Charging at Non-home Locations: around 40% of the dwelling time intervals at non-home locations are within 20 mins, showing a big potential for fast charging facilities being used at non-home locations, including working, shopping and other public places;
- Home charging should still be the dominant charging pattern: at the state average level, people spend 73% of the time at home;
- Potential for demand management by optimally scheduling charging activities into charging opportunities.



Results

	1	31 VARIABLE chargingTime.L		
	INDEX $1 = i1$			
ngTime(i,t,r,l): charging time of individual i at region r in time		11		
n level I charger;	t9 .r2	0.319		
	t10.r2	1.000		
harger(r,I): number of charger at level I built at region r, integer	t11.r2	1.000		
	t12.r2	1.000		
	INDEX 1 =	12		
		11		
nargingCost =	t4 .r3	0.454		
	t10.r1	1.000		
cnargingPrice(t,r,i)*cnarging i ime (i,t,r,i)*cnargerPower(i)	tll.rl	1.000		
Cost(r I)*numCharger(r I):	t12.rl	1.000		
	tl3.rl	1.000		
	INDEX 1 =	13		
		11		
$_{1}$ chargingTime(i,t,r,l)* chargerPower(l) - energyDem(i) > 0;	t3 .r2	1.000		
T = (1 + 1) + 4	t4 .r2	1.000		
$ g me(i,t,r,l) \leq 1;$	t9 .rl	1.000		
$a_{in} a_{in} T_{in} a_{in} (i + \pi I)$ $a_{in} a_{in} T_{in} a_{in} (+ i + \pi) < 0$	t10.r1	1.000		
ging $I \text{ ime}(I,t,r,I)$ - dweiling $I \text{ ime}(t,I,r) \leq 0$;	tll.rl	1.000		
aim aTim a(i + m l) num Chargor(r l) < 0;	t12.r1	1.000		
$y(ny)(ne(t,t,r,t) - nuncharger(1.1) \le 0,$	t14.r3	1.000		
	613.13	0.416		

- Expand the current demo optimization model to the comprehensive model for CA with over 100 thousands individuals and over 1750 zip code levels: 1. Computational limit
 - 2. Real-time price at zip code levels
- 3. More constraints: limited budget/ battery size
- Integrating grid operation / renewable benefits into the optimization model more comprehensive.
- Consider the constraints of electric grid, or the benefits to renewables integration into the EV charging system design.
- Conduct scenario analysis, investigating the impacts of new mobilities, such as shared mobility and vehicle automation, to charging opportunity distribution.



