Keeping Plug-in Electric Vehicles Connected to the Grid – Patterns of Vehicle Use

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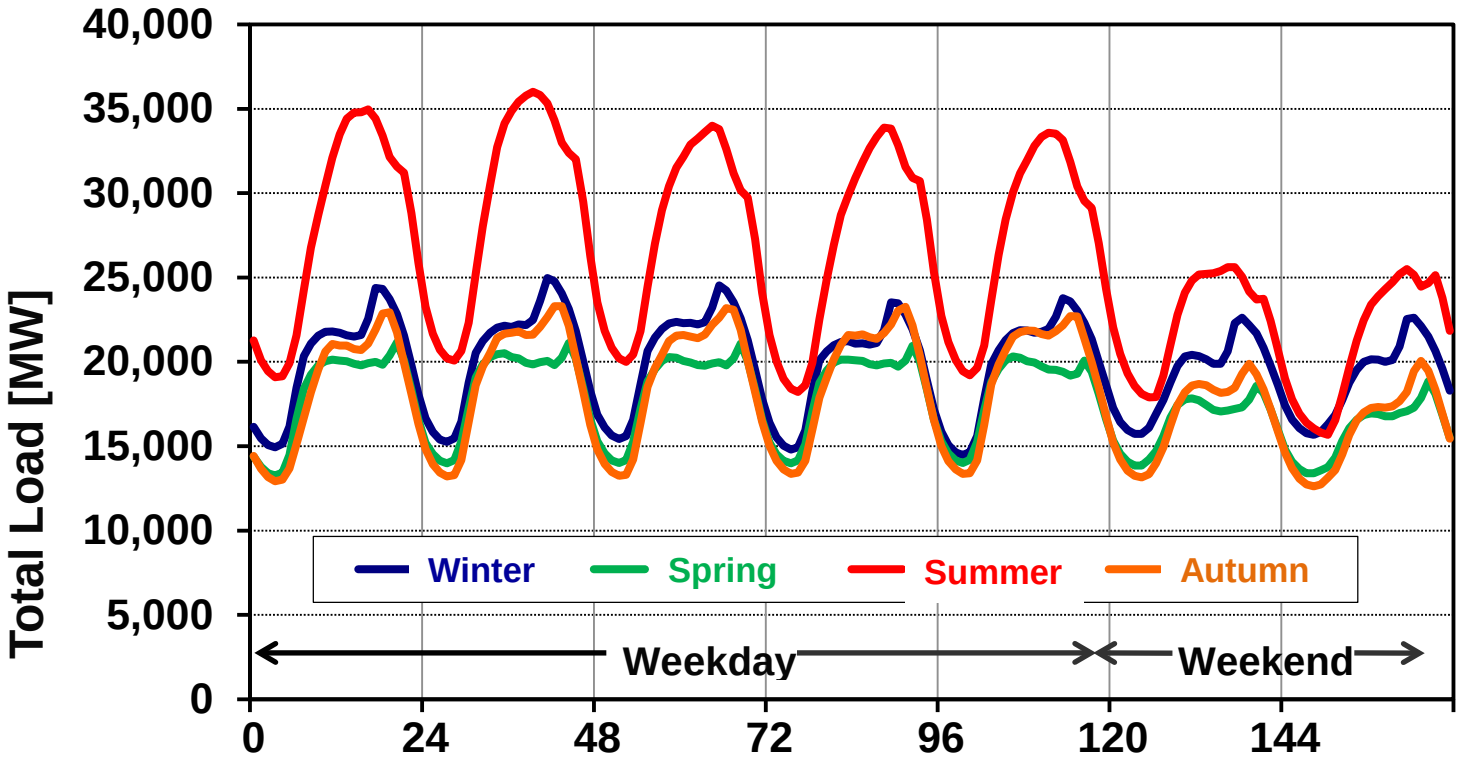
Workplace air conditioning causes mid-afternoon summertime demand peaks. Late afternoon & early evening return to houses cause appliance use & other seasonal peaks. Vehicles are usually in different places for these two peak types.

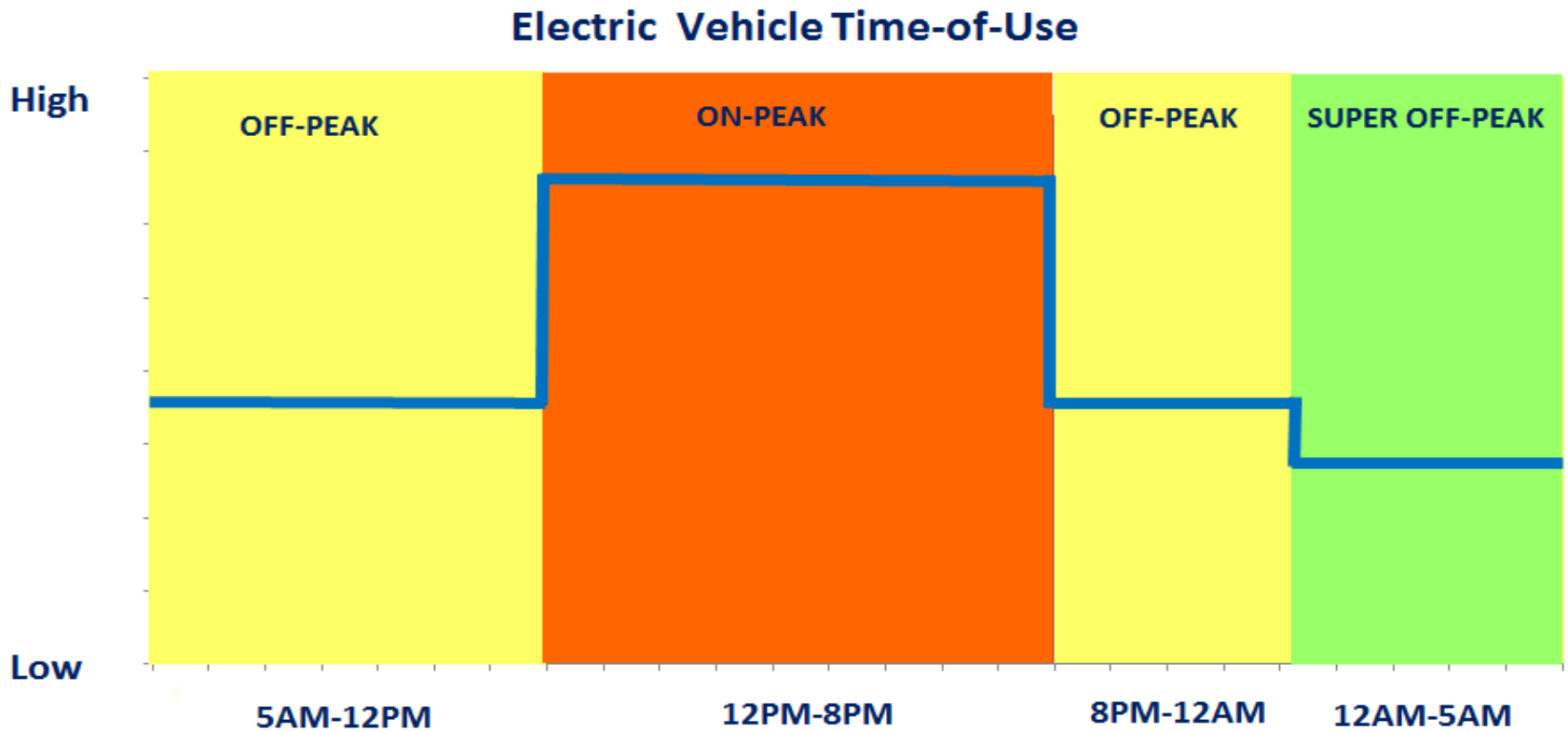


NY-ISO Seasonal Load Profiles - Hour in Week

For PG&E, summer peak electrical rates deter afternoon & early evening charging at residences on workdays, not weekends

	Hour																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Monday	Off peak (lowest rate)							Partial peak							Peak							Partial peak		
Tuesday																								
Wednesday																								
Thursday																								
Friday																								
Saturday								Off peak									Partial peak				Off peak			
Sunday																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Hour																							

SDGE time of day residential EV rates strongly discourage plugging in during the afternoon, slightly encourage the evening. Can EVs coming home charge a second time before the peak?



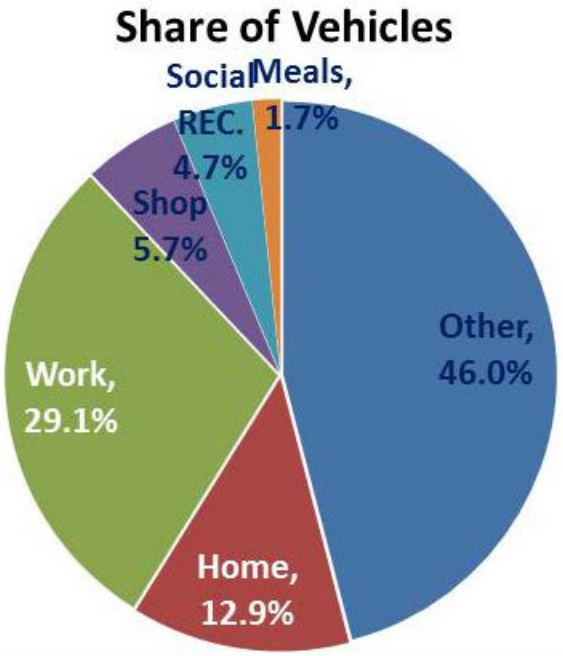
OFF-PEAK: Medium energy cost daily
ON-PEAK: Highest energy cost daily
SUPER ON-PEAK: Lowest energy cost daily

For more information on electric vehicle rates visit *sdge.com/CleanTransportation*

EV & PHEVs require intensive use to pay off. Many EV driving intensively (>=50 mi/day) will want or need a second charge. PHEVs owners will not need one.

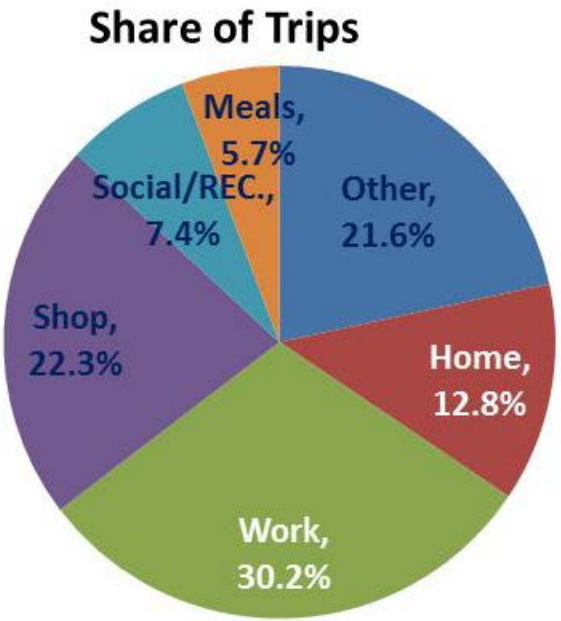
- **Electric Vehicles**
  - http://www.fueleconomy.gov/feg/evsbs.shtml
  - Currently rated vehicles are:
    - 2011 Nissan Leaf (5 passengers, 73 mi. range)
    - 2011 smart fortwo electric (2 passengers, 63 mi.)
    - 2012 Mitsubishi i-MiEV (4 passengers, 62 mi.)
    - 2012 Azure Dynamics Transit Connect (cargo van, 56 mi.)
- **Plug-in Hybrids and Extended Range Electrics**
  - http://www.fueleconomy.gov/feg/phevsbs.shtml
  - Currently rated vehicles are:
    - 2011 and 2012 Chevrolet Volt (4 passengers, 35 mi. range)

If second charges are desired prior to 12PM, about half of vehicles can do so at home or work



Others includes school, medical, personal business, transport etc.

Note: This sample only includes vehicles that start from and end at home.

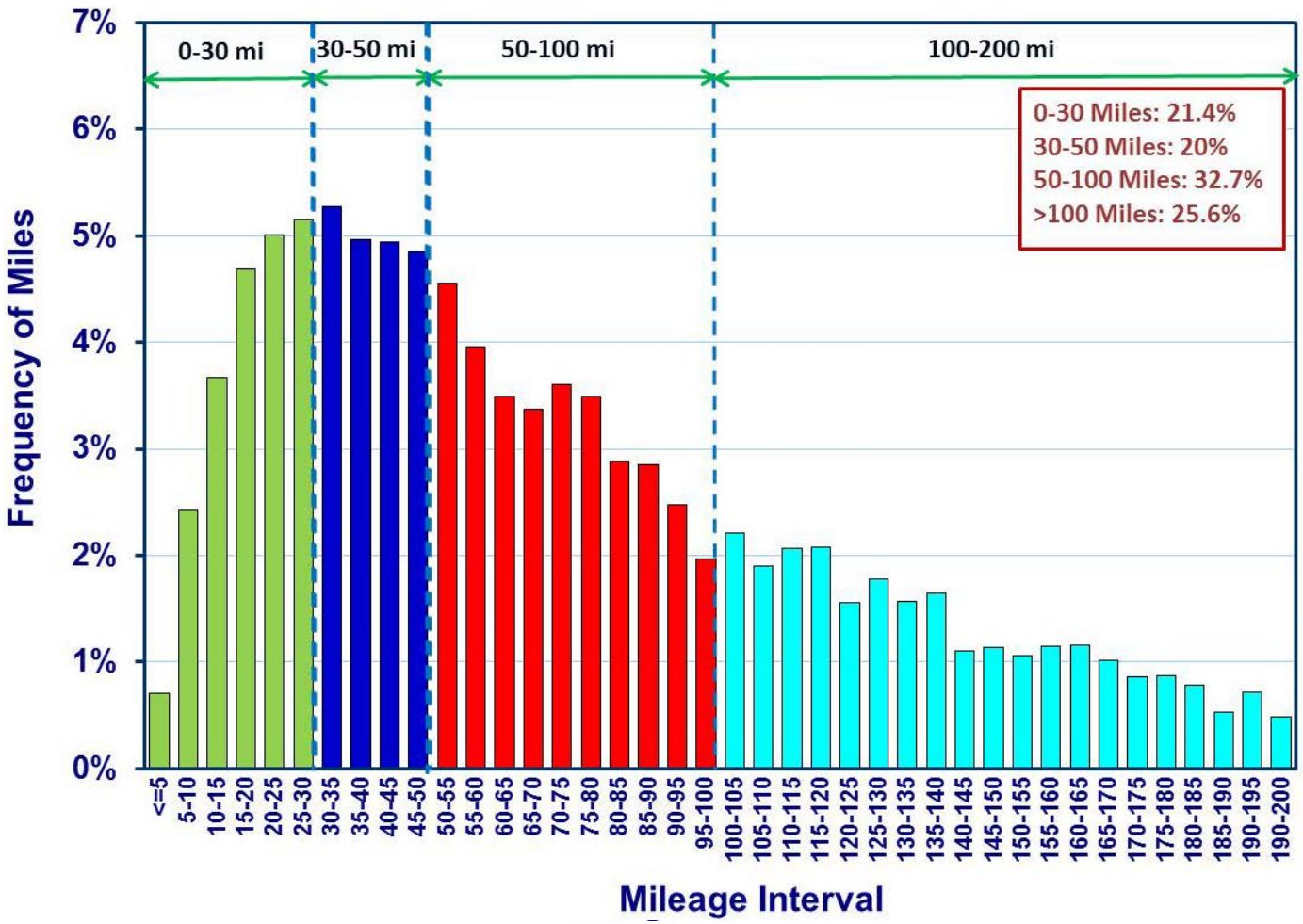


Vehicle location and use patterns between 6 AM to 12 PM

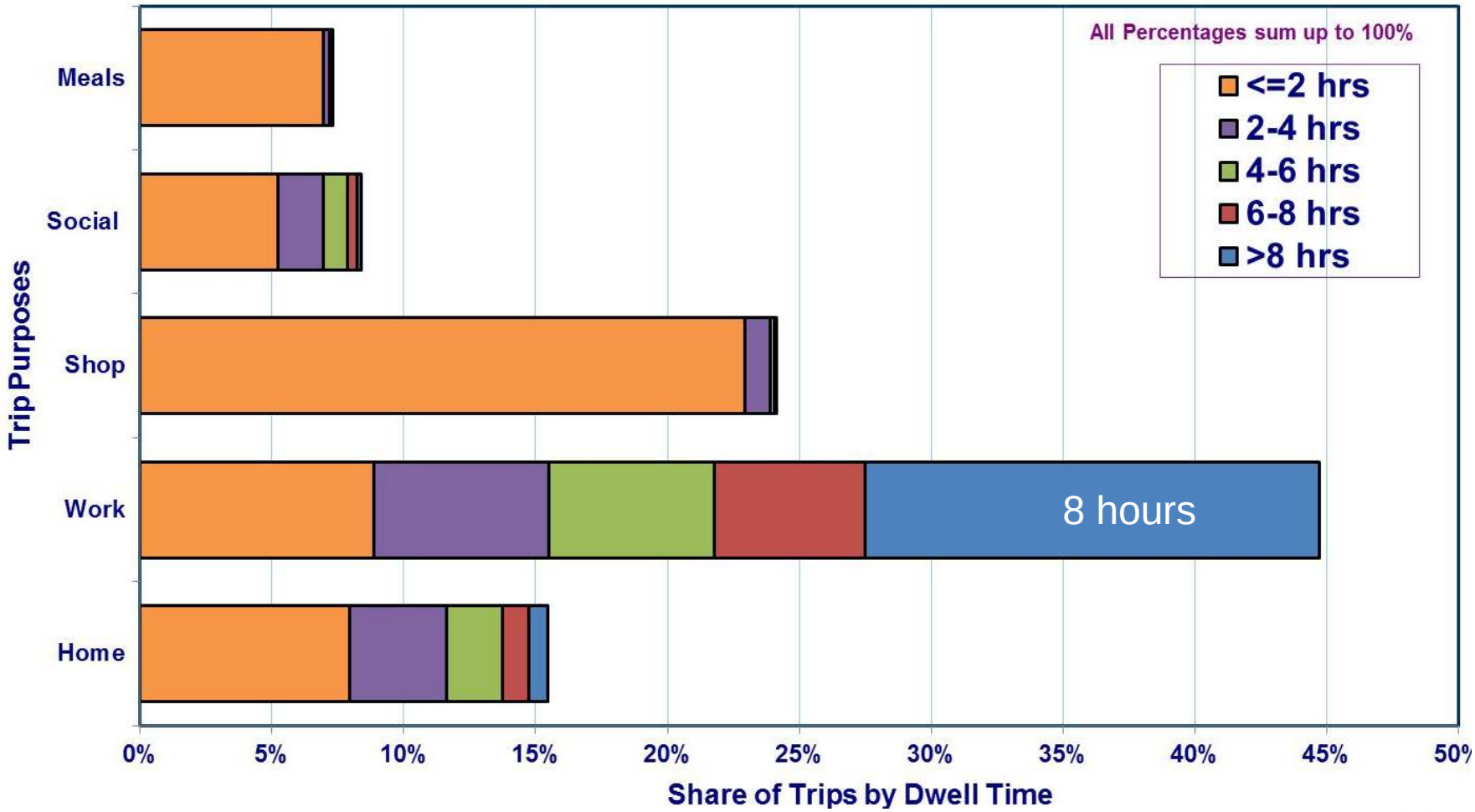
Focusing on returns to home and work use, we studied the longest time interval for second charges starting before 12pm, by location, time, and duration

- Two perspectives: Vehicle use, Driver Trips
- Control factors
  - Purposes: Work, Home, Shop, Social, Meals
  - Vehicle Types: Car, SUV, Van and Pickup
  - Home Types: Detached Single/Duplex/Row/Townhouse
  - Daily Mileage
  - Begin time of dwell time
  - Dwell time

Although a small share of vehicles are driven intensively, they do account for a significant share of miles. We examine three high daily use brackets.

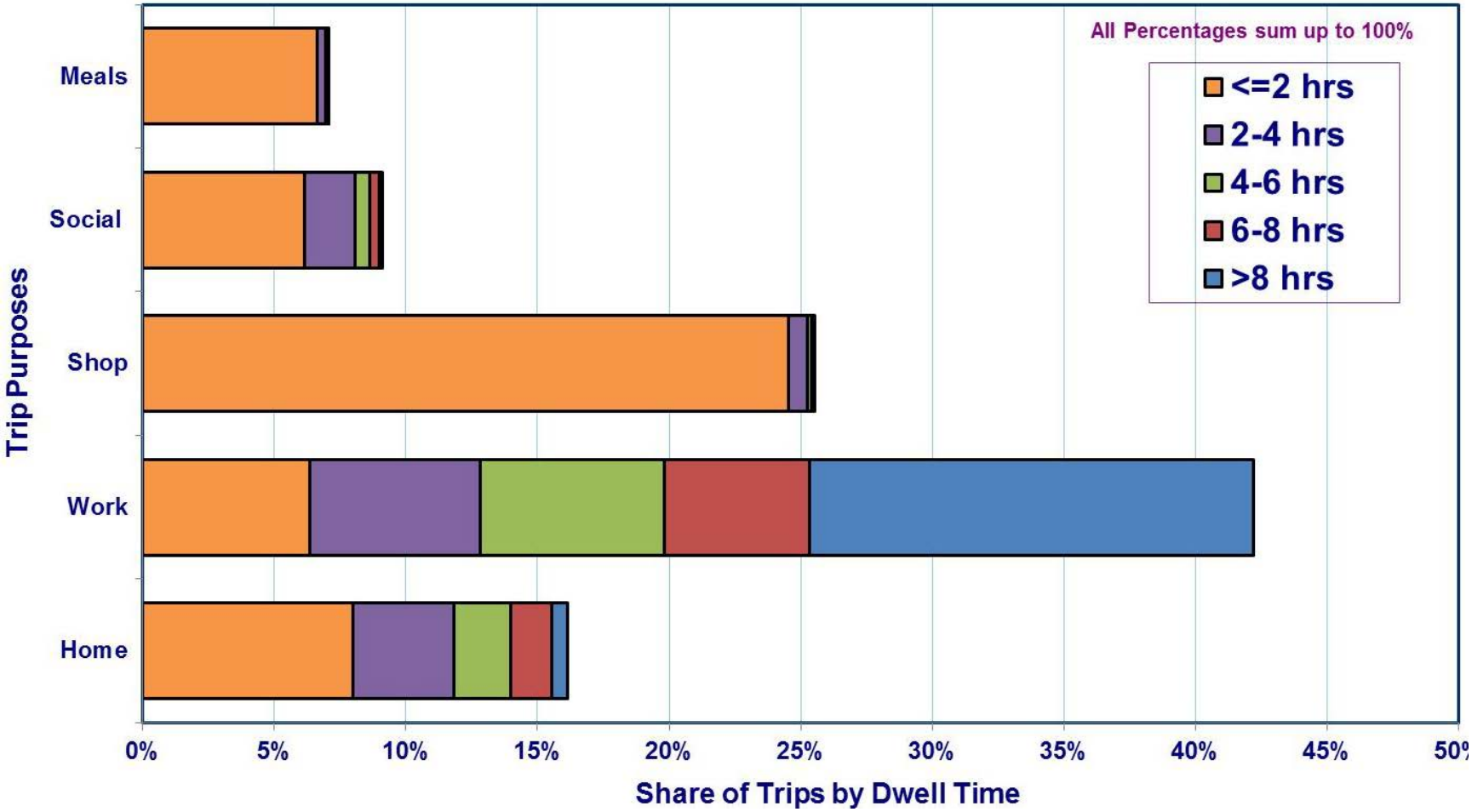


Short dwell times dominate all trip purposes other than work



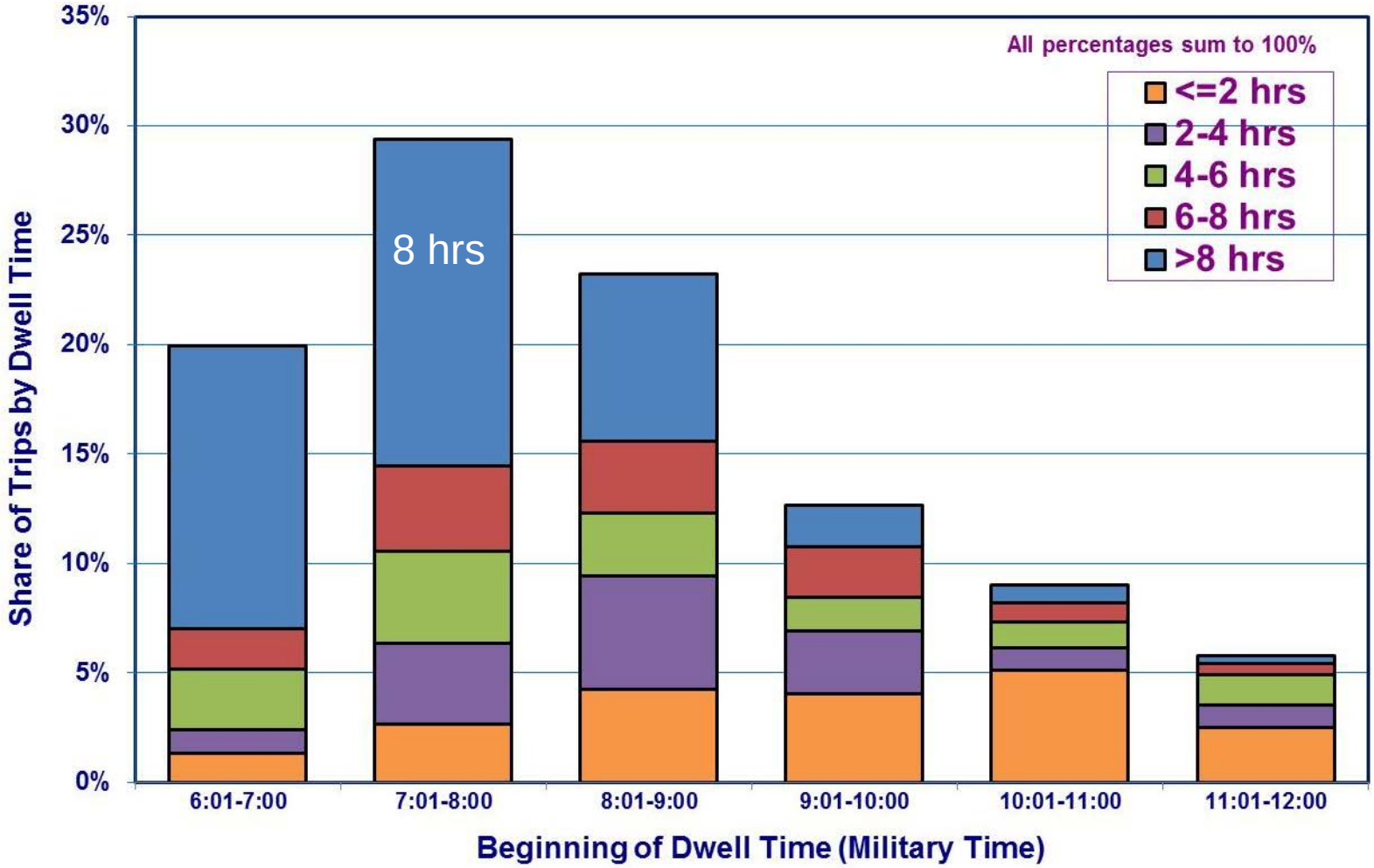
For vehicles driven 50-100 mi/day for trips ending between 6 am & 12 pm

The mix of work charging opportunities did not vary from 30 miles and above



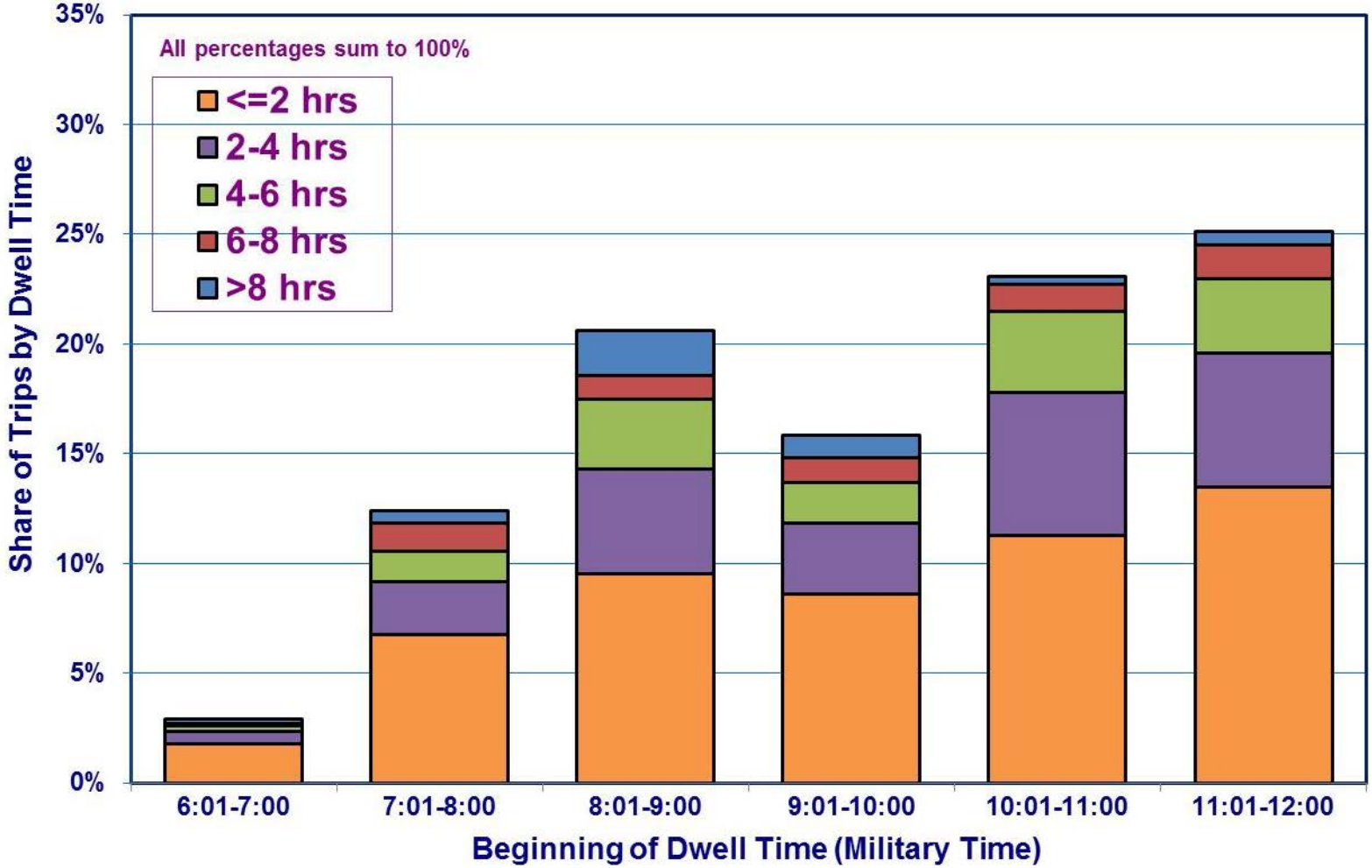
For vehicles driven 30-50 mi/day for trips ending between 6 am & 12 pm

Most trips made to work with dwell time longer than 4 hours are early in the morning



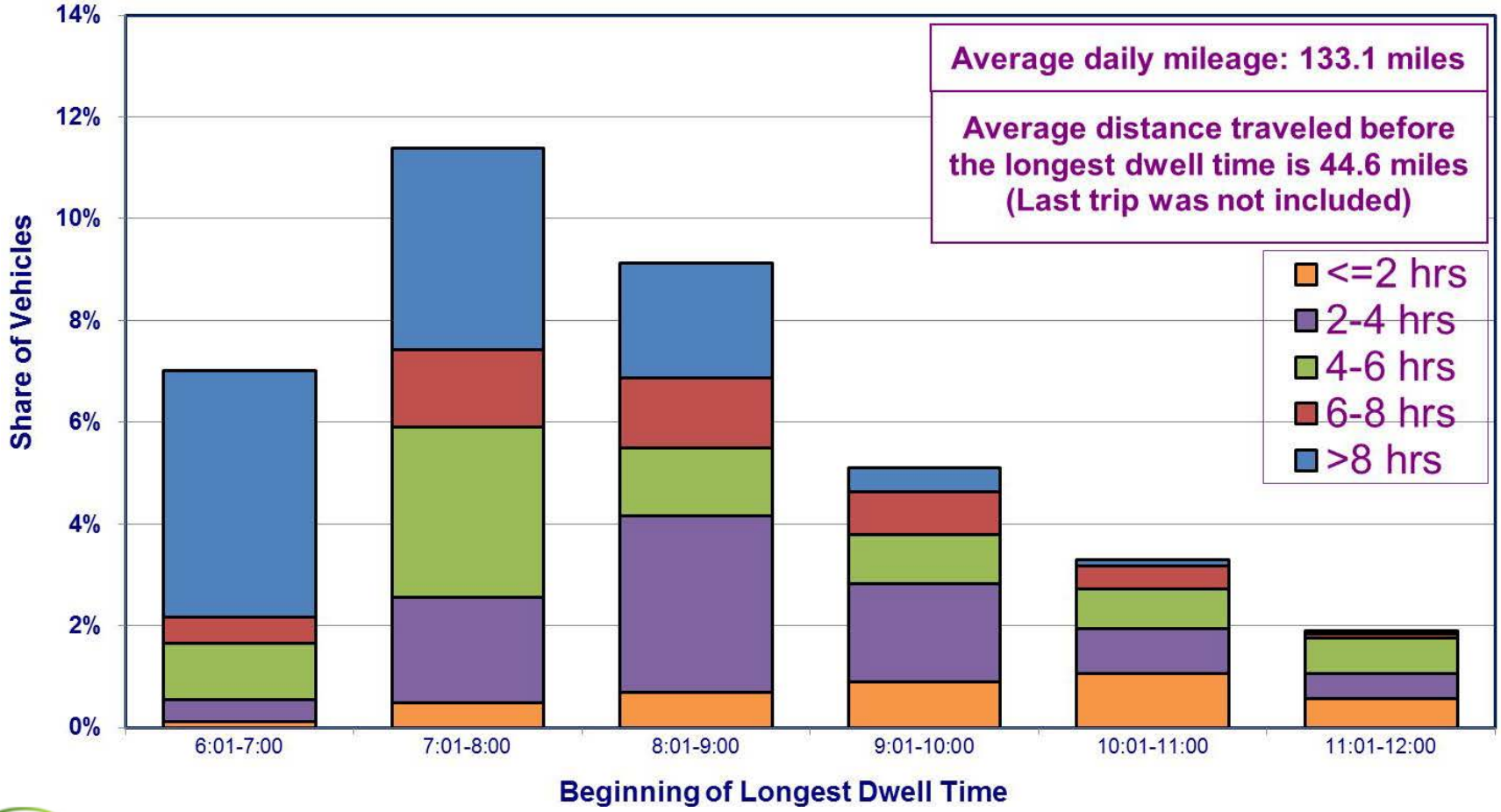
For vehicles driven to work, 50-100 mi/day for trips ending 6 am to 12 pm

Vehicles returning home arrive much closer to the afternoon peak and remain parked for far less hours



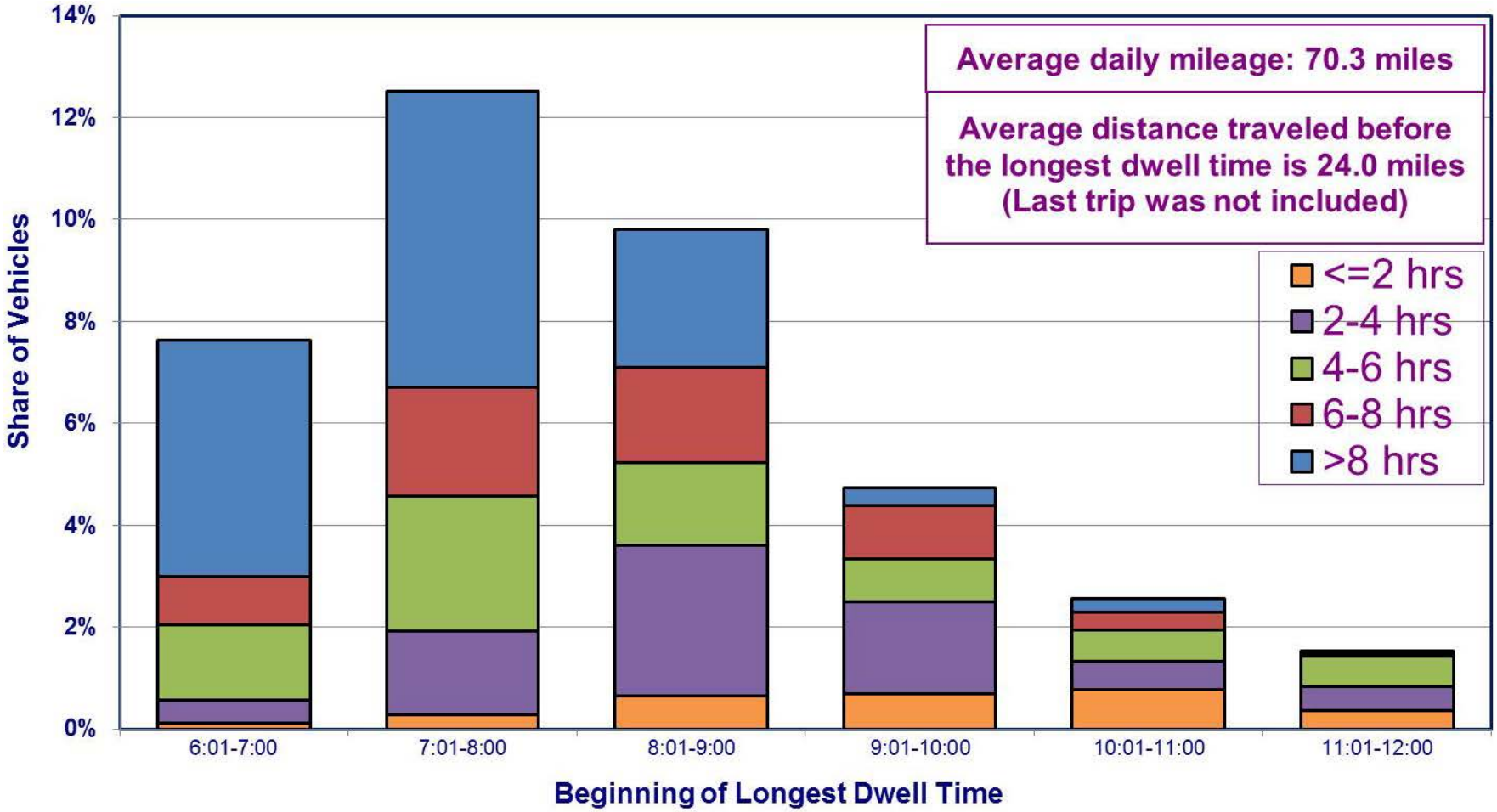
For vehicles returning home, driven 50-100 mi/day, trips ending 6 am to 12 pm

In the > 100 mile group, many EV drivers would experience range anxiety, definitely need multiple charges. Unless work charged, PHEVs would not electrify a large % of miles.



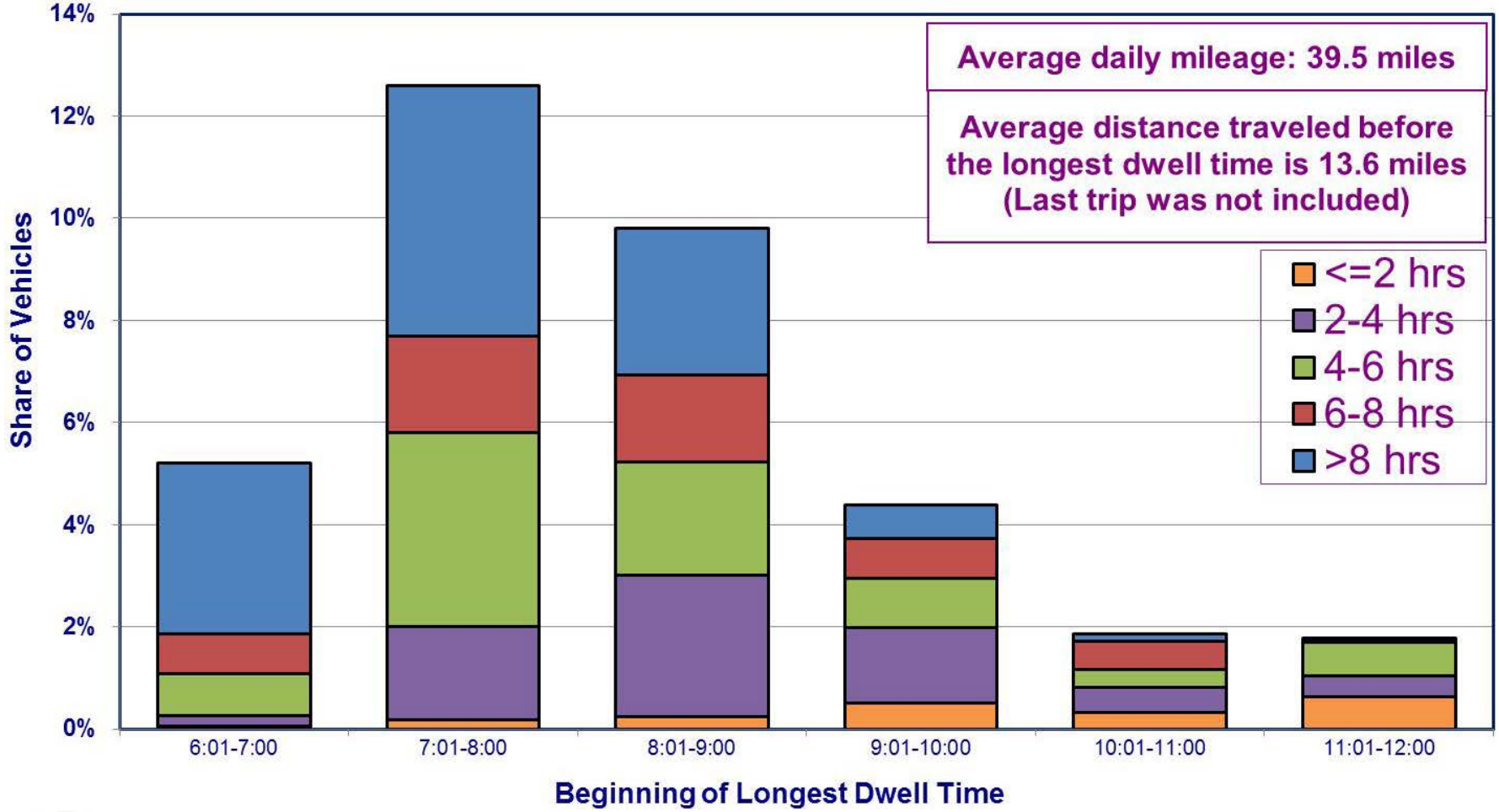
For vehicles going to work and driven 100-200 miles per day

Many in the 50-100 mile group could not empty a Volt pack before work arrival. Many EV owners will want a work top off.



For vehicles going to work and driven 50-100 miles per day

Both EVs and Volt-like EREVs could serve the 30-50 mile group comfortably, w/o workplace charging



For vehicles going to work and driven 30-50 mpd

Conclusions/Discussion

- Vehicles returning to home represent less than 15% of vehicles. Many of these may not have time for a second charge that avoids the summer afternoon peak.

- Workplaces are the best place for non-residential chargers. A majority of vehicles driven to work have > 4 hrs. for a second charge before the afternoon summer peak.

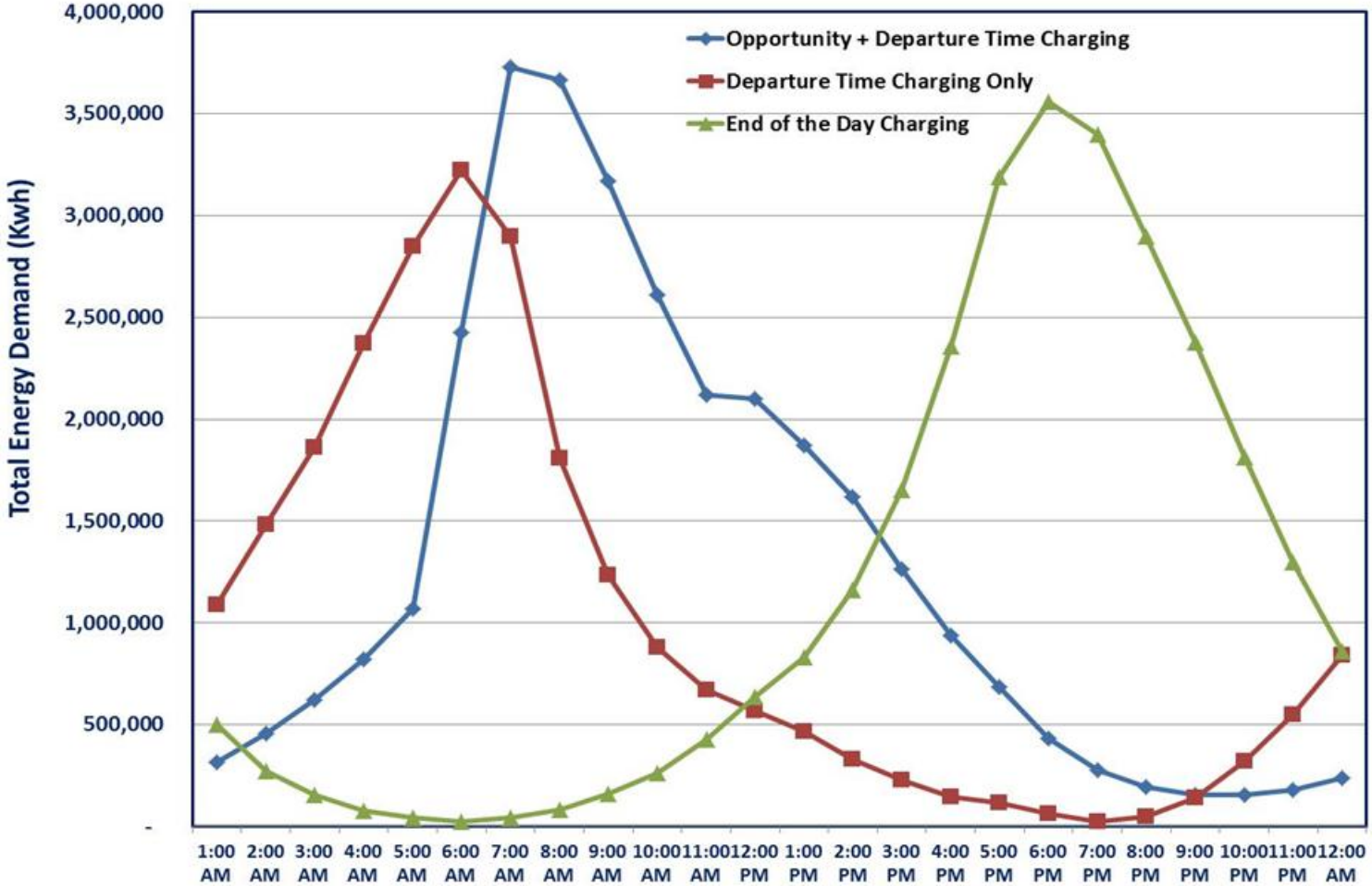
- To take greatest (national fuel saving) advantage of second charges after work arrival the greater the pack depletion before arrival at work the better

Conclusions/Discussion (cont.)

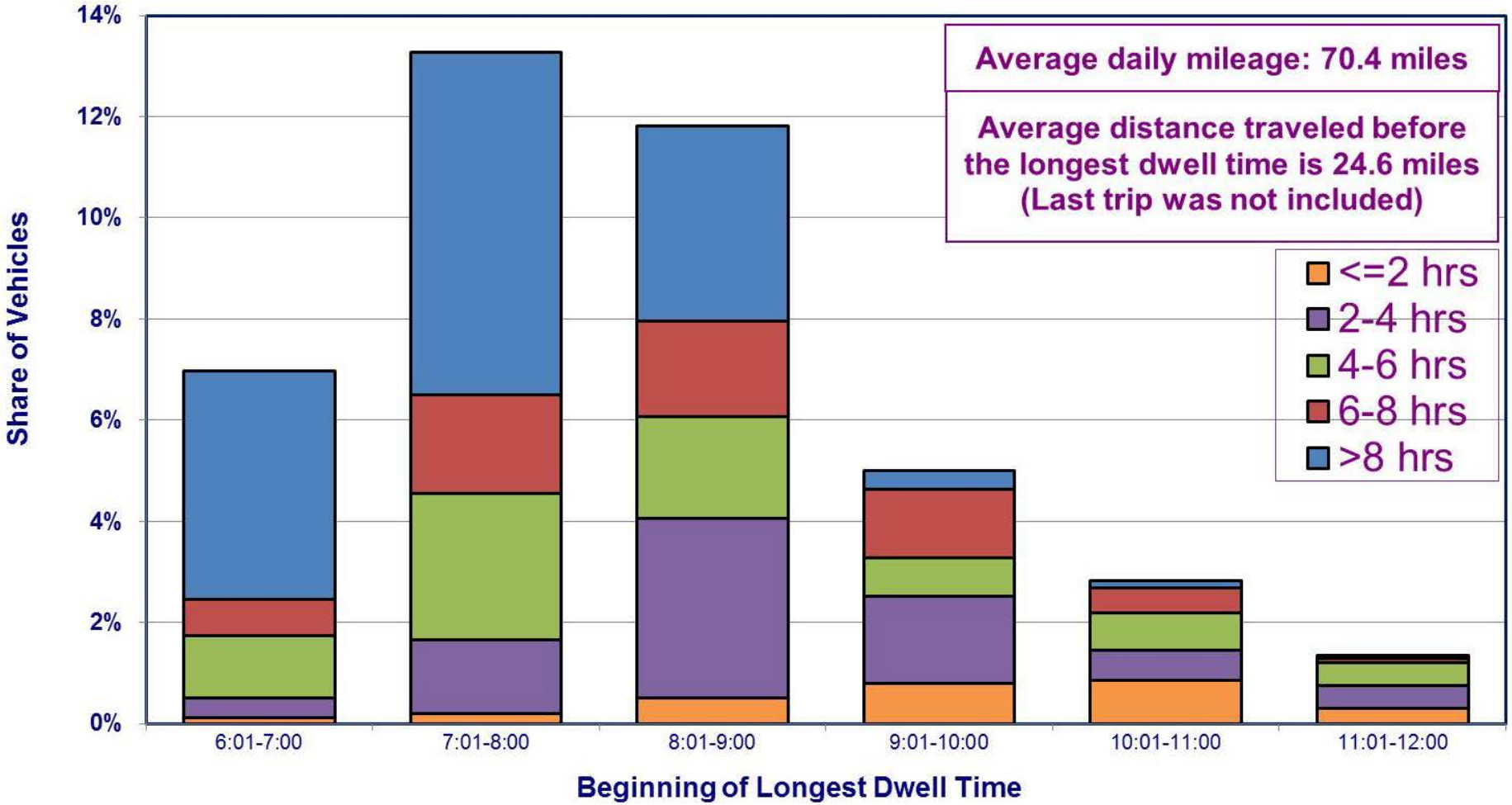
- Of the vehicles starting from and returning to home, only 24.4% travel > 50 miles, but these contribute 58.3% of vehicle miles. Thus, plugs for 24.4% target 58.3% of miles.
- Of these, for the minority subset driven to work, plugs at work should enhance the acceptability of the plug-in electric option, without increasing summer peak demand.
- For the >100 mpd group, most EVs will *require* a workplace charge depending on the range. Without work charging a VOLT would electrify only a minority of the miles in this group.
- For the 50-100 mpd group, on average, a VOLT with one charge could electrify half of miles, nearly all with 2 charges. Work plugs would reduce EV range anxiety and dinnertime recharges.

- Additional Slides

PHEVs load profile can vary considerably with charging scenario (figure shown for U.S. WECC service area)

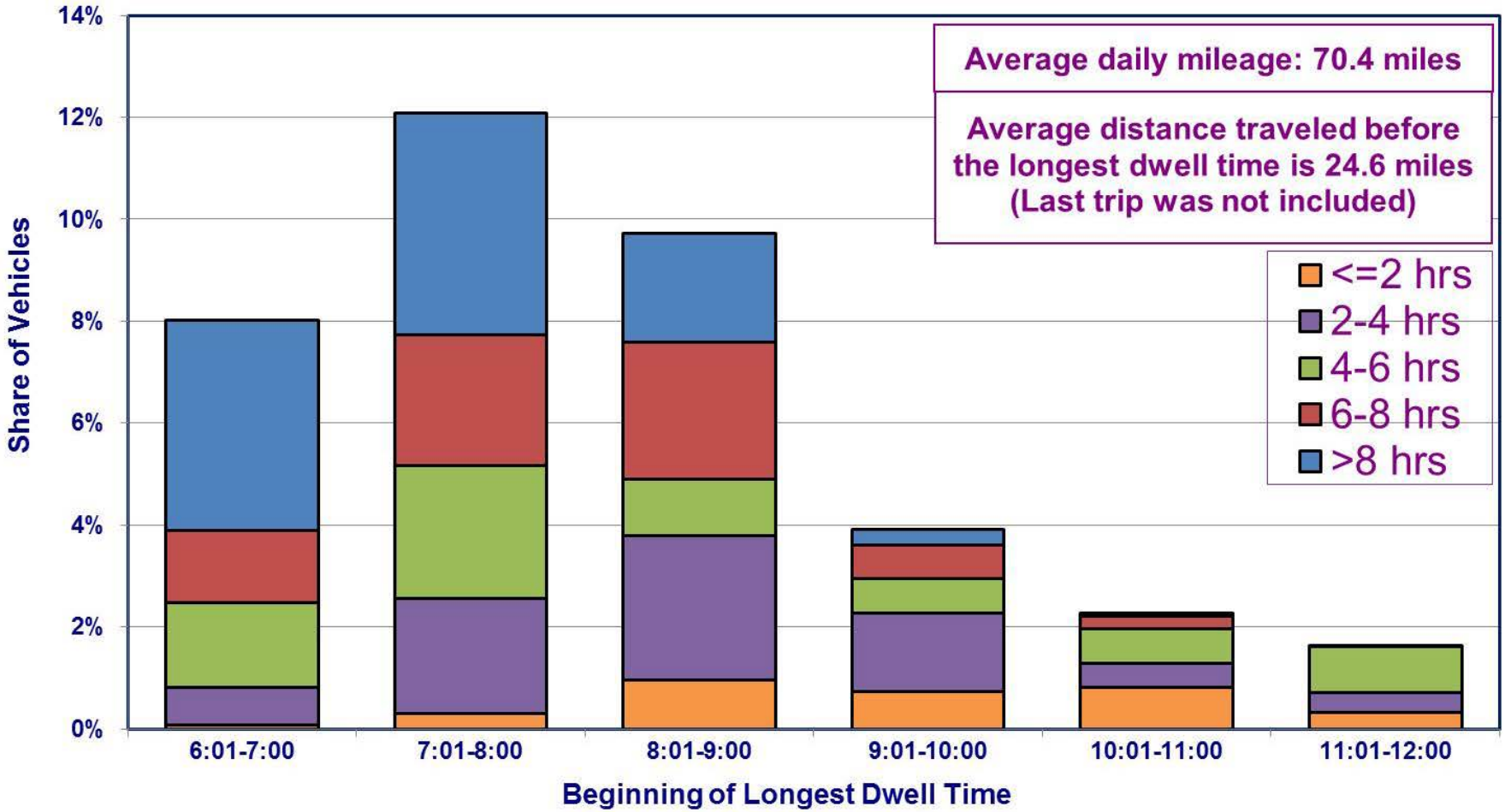


Cars driven to work



For cars driven 50-100 mpd

SUV driven to work



For SUVs driven 50-100 mpd