



Variation in Charging of Privately-Held PEVs

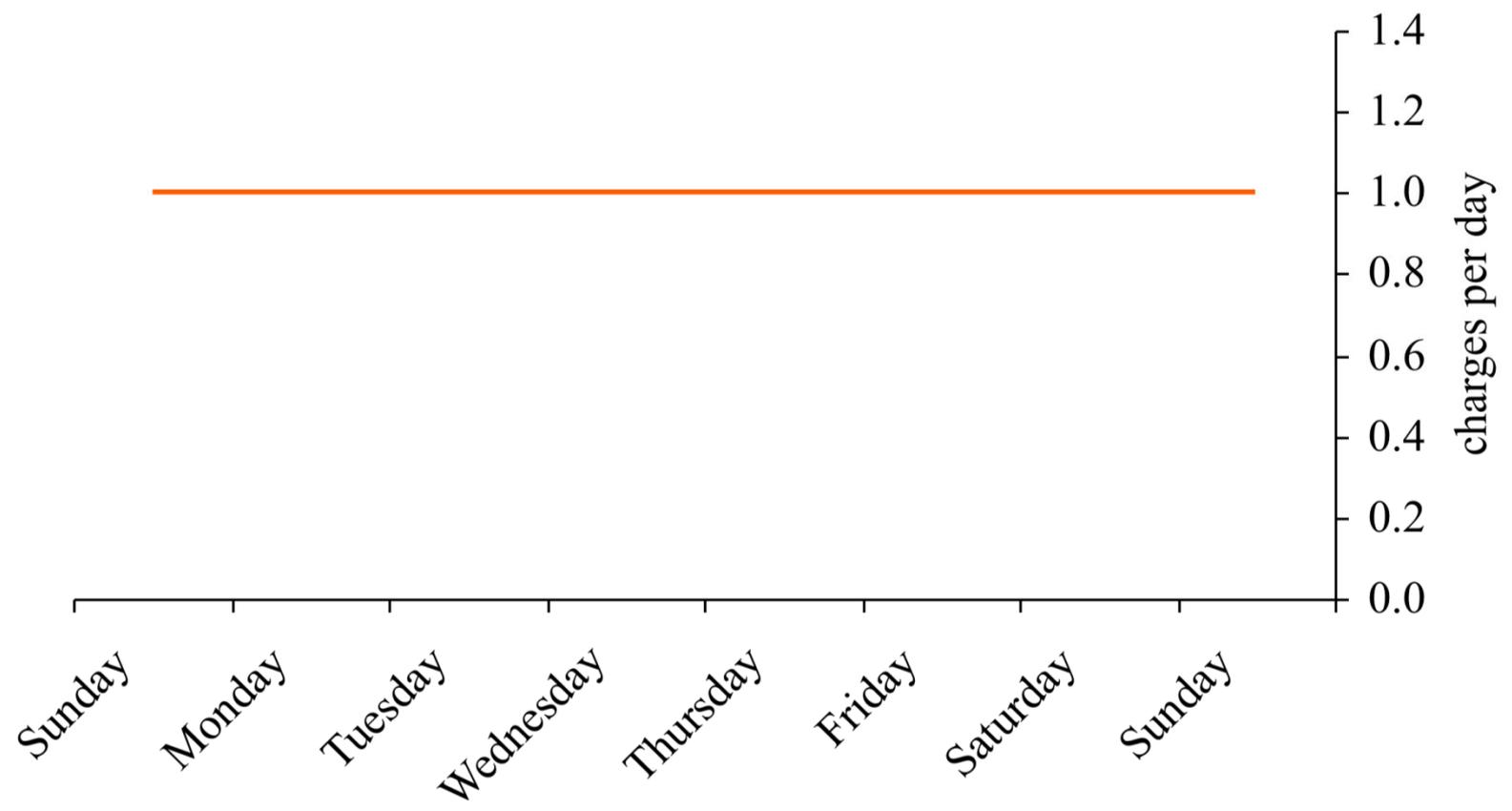
Workshop 137: Transitioning to Plug-in Electric Vehicles: Challenges and Best Practices

Ken Kurani
13 January 2013

How we know what we think we know about variability in charging

- Short-term PEV trials; medium-term PEV ownership and leases
- Particular vehicles
 - Mid-CD range PHEVs, “low” range BEVs
- Households with access to home charging
 - Away-from-home charging has been free.

Oft-used assumption of a uniform one-charge per day



Averages...

Nissan Leaf drivers were charging their vehicles
1.1 times per day on average...

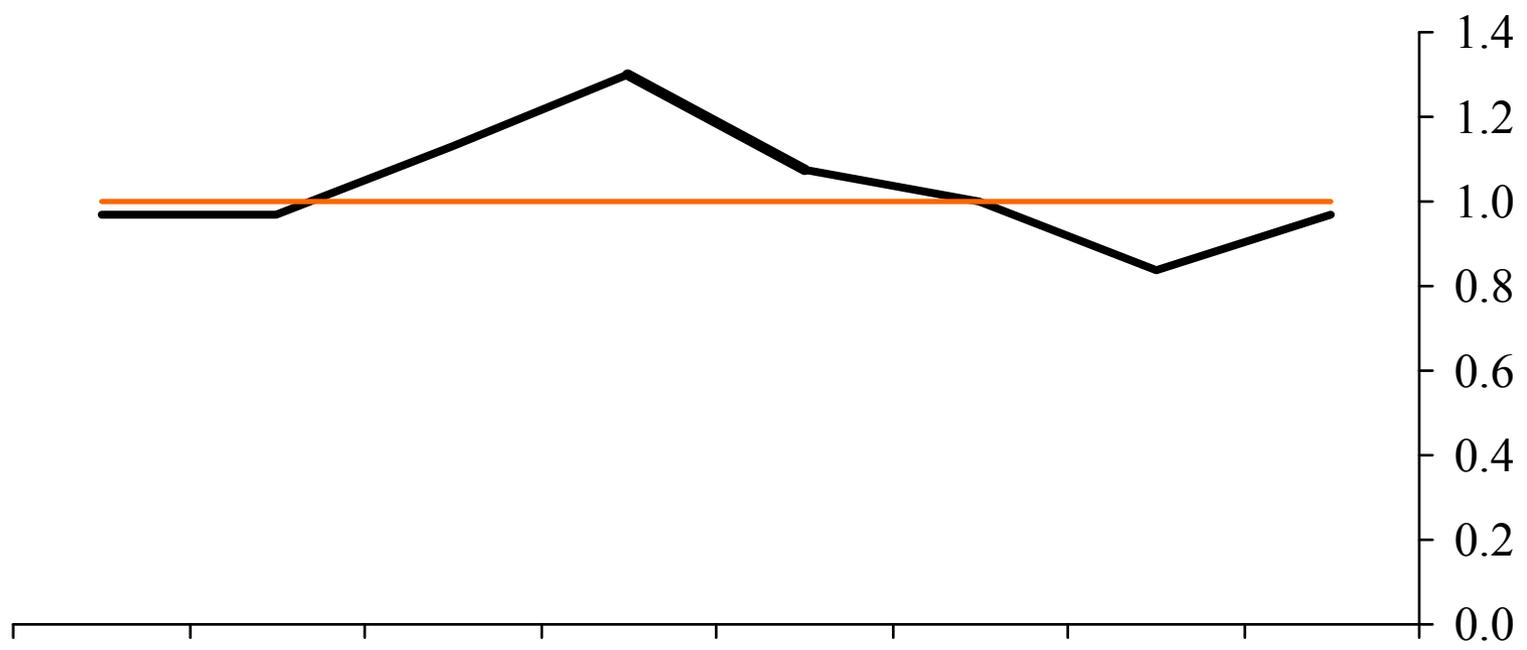
...Chevrolet Volt drivers, 1.5

[Steve Schey (2012) Crunching the Big Data of EV Charging: A Q&A with ECOtality on what 1 million “charge events” in the DOE-backed EV Project can tell us.” October 8.
<http://www.greentechmedia.com/articles/read/crunching-the-big-data-of-ev-charging>]

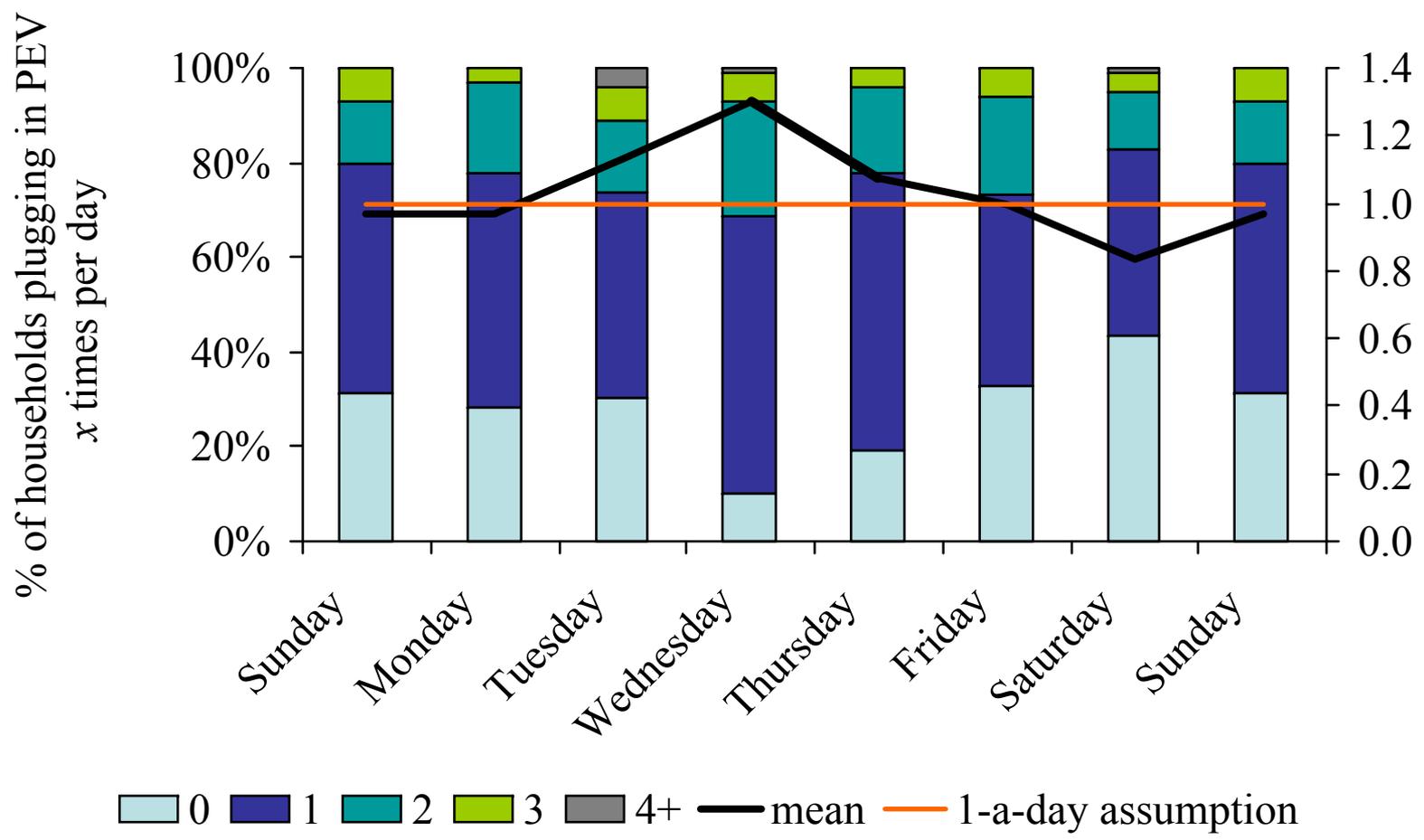
...and generalizations

“While we still expect the majority of charging to take place at home, we’re excited to see that in the past three months [3rd quarter, 2012], public charging has increased by 25 percent. This shows that *drivers are becoming more and more comfortable with stretching the range of their vehicles and utilizing the public infrastructure available.*” Schey, 2012.

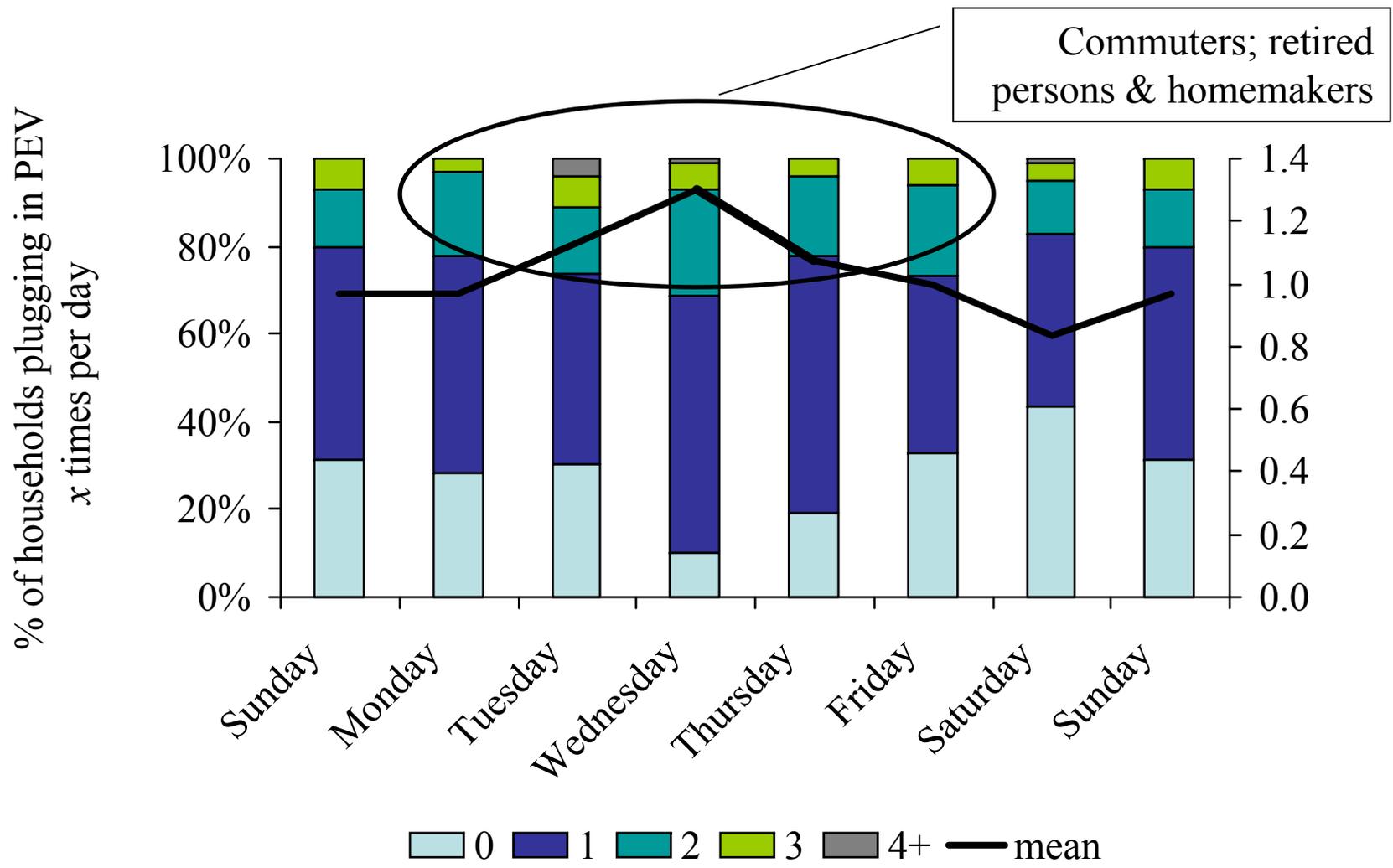
67 one-week data sets from the last week of a one-month household PHEV trial



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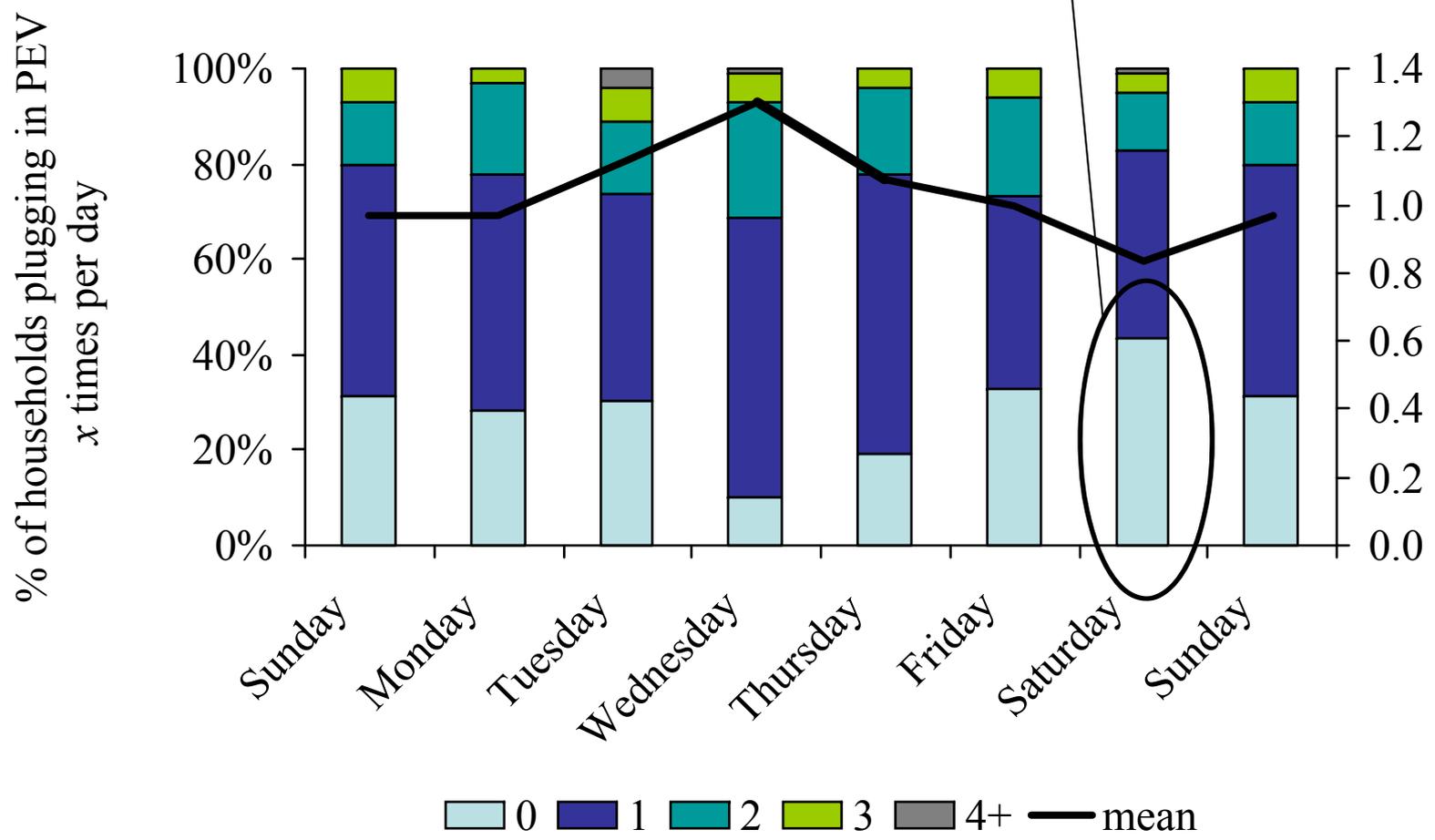


Variation within and across households

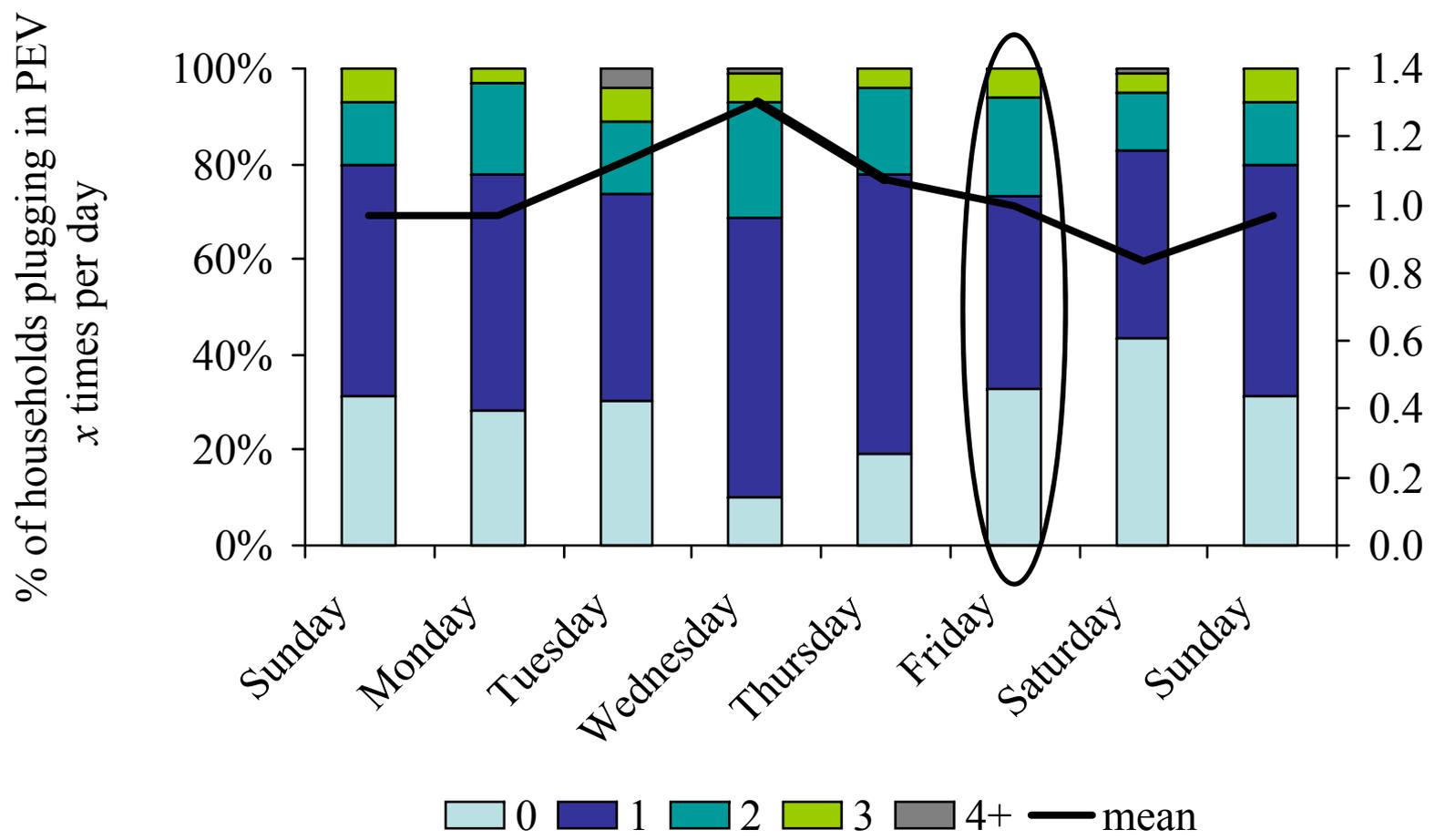


Variation within and across households

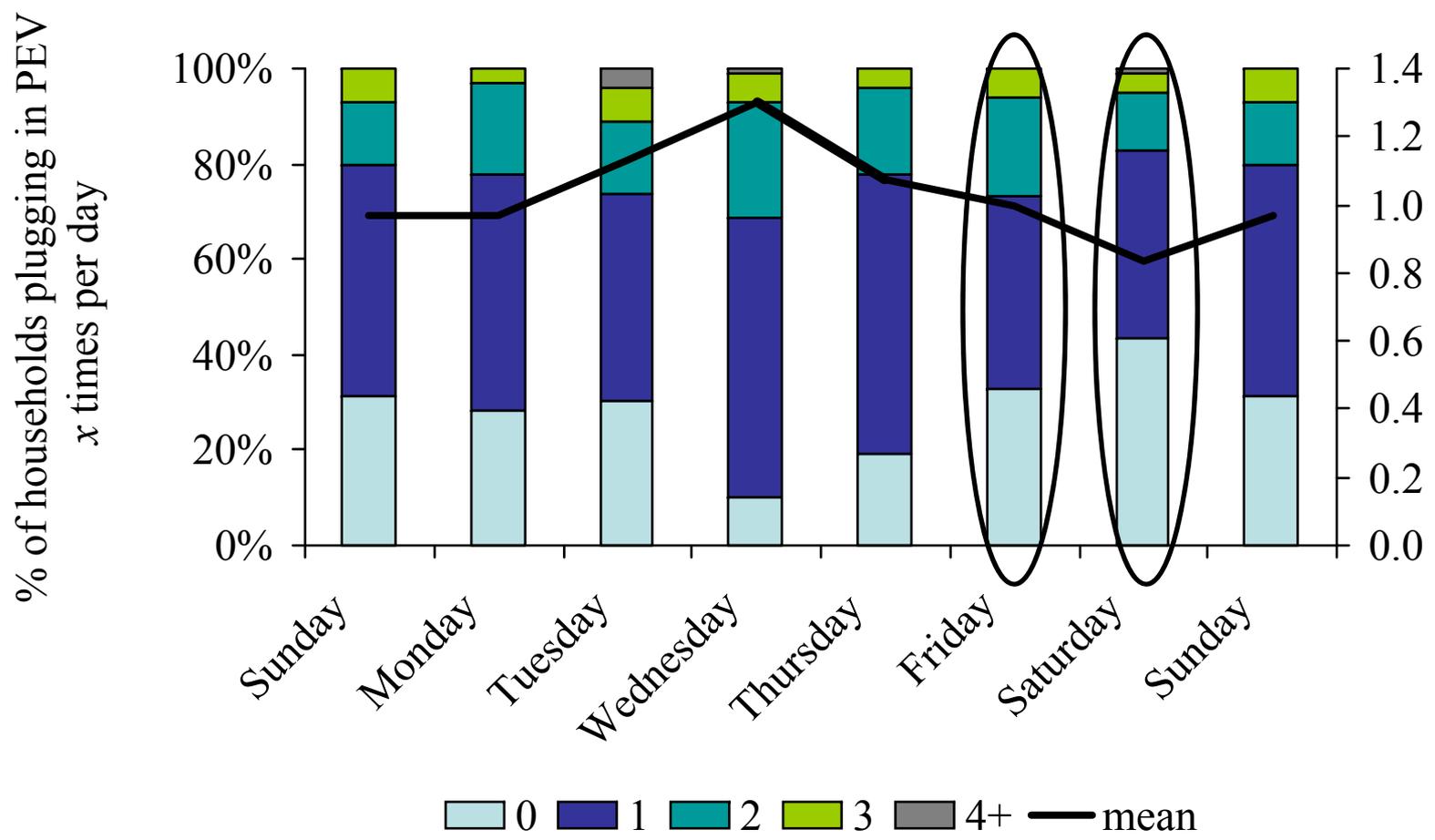
Long-distance travel away-from-home; cars left at home



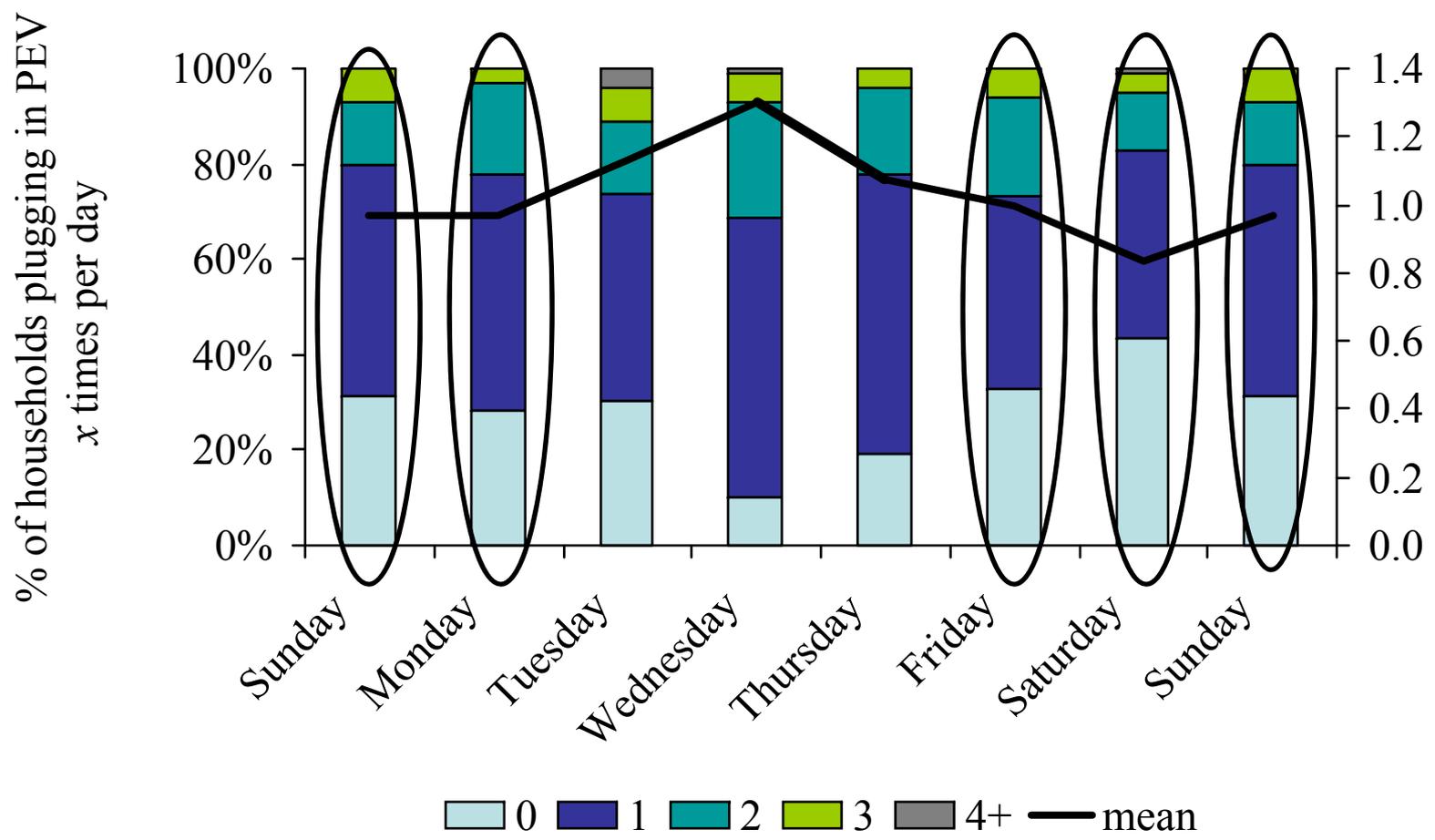
Evidence for serial correlation?



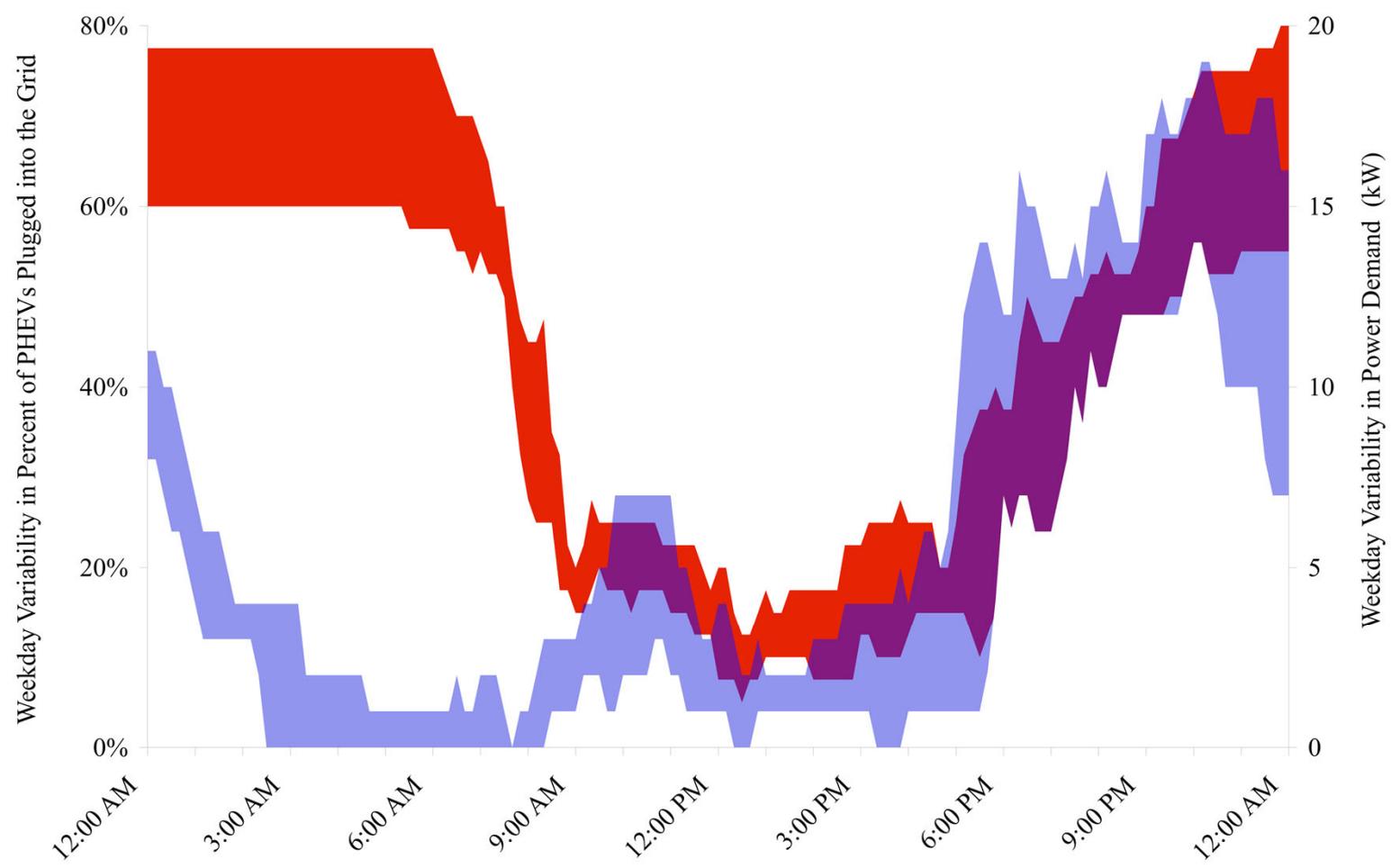
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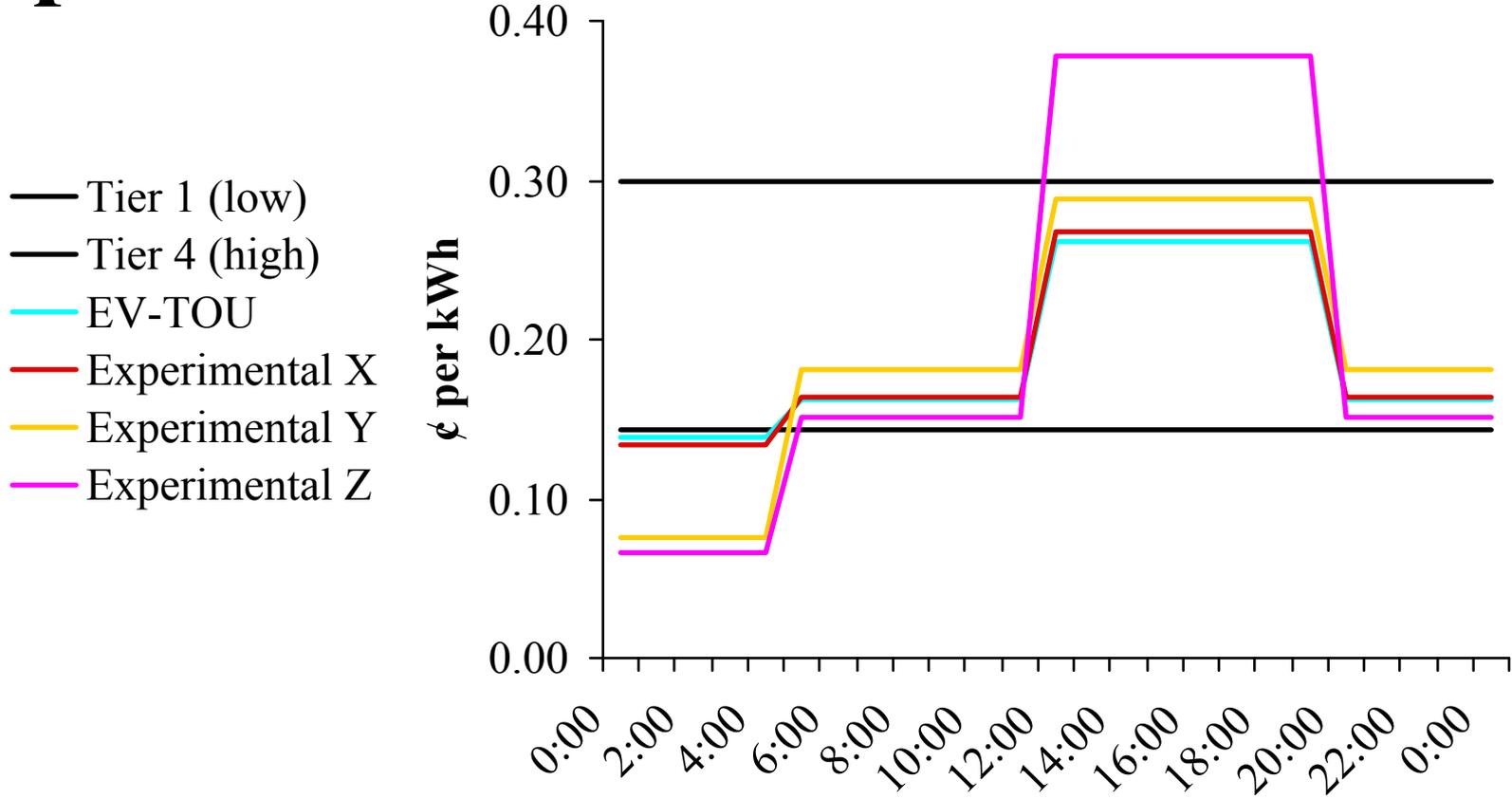
Weekday charging variability across households



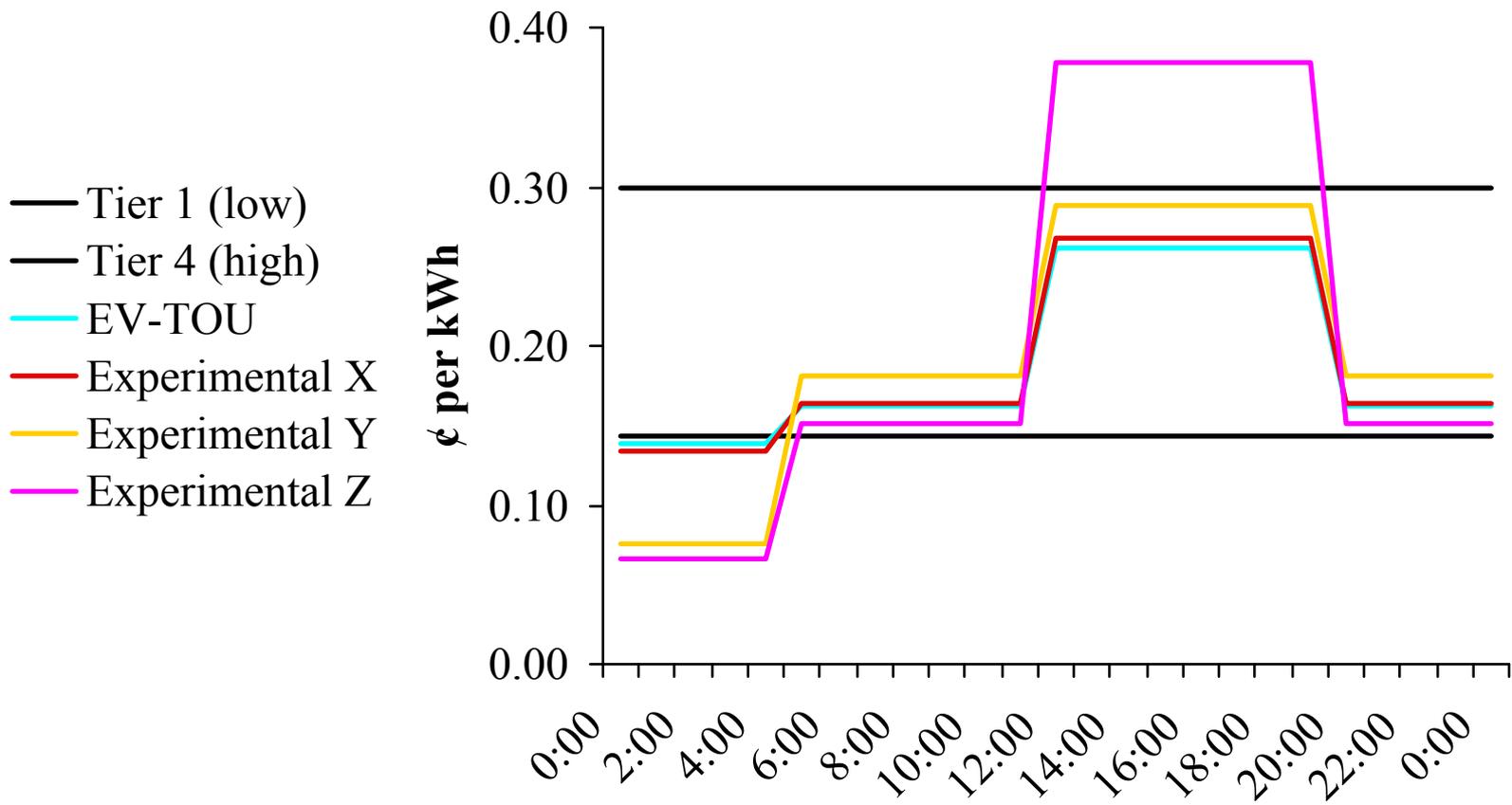
Time-of-day variability shaped by Demand Response Management

- Pricing
 - Correlation between time of day demand for travel and charging and the model for public charging
- Technology
 - Timers to establish and sustain routines
 - Missed charges
- Exhortation
 - Social narratives about electricity demand support other DRM tactics

San Diego Gas & Electric Summer Experimental PEV Time-of-use Tariffs

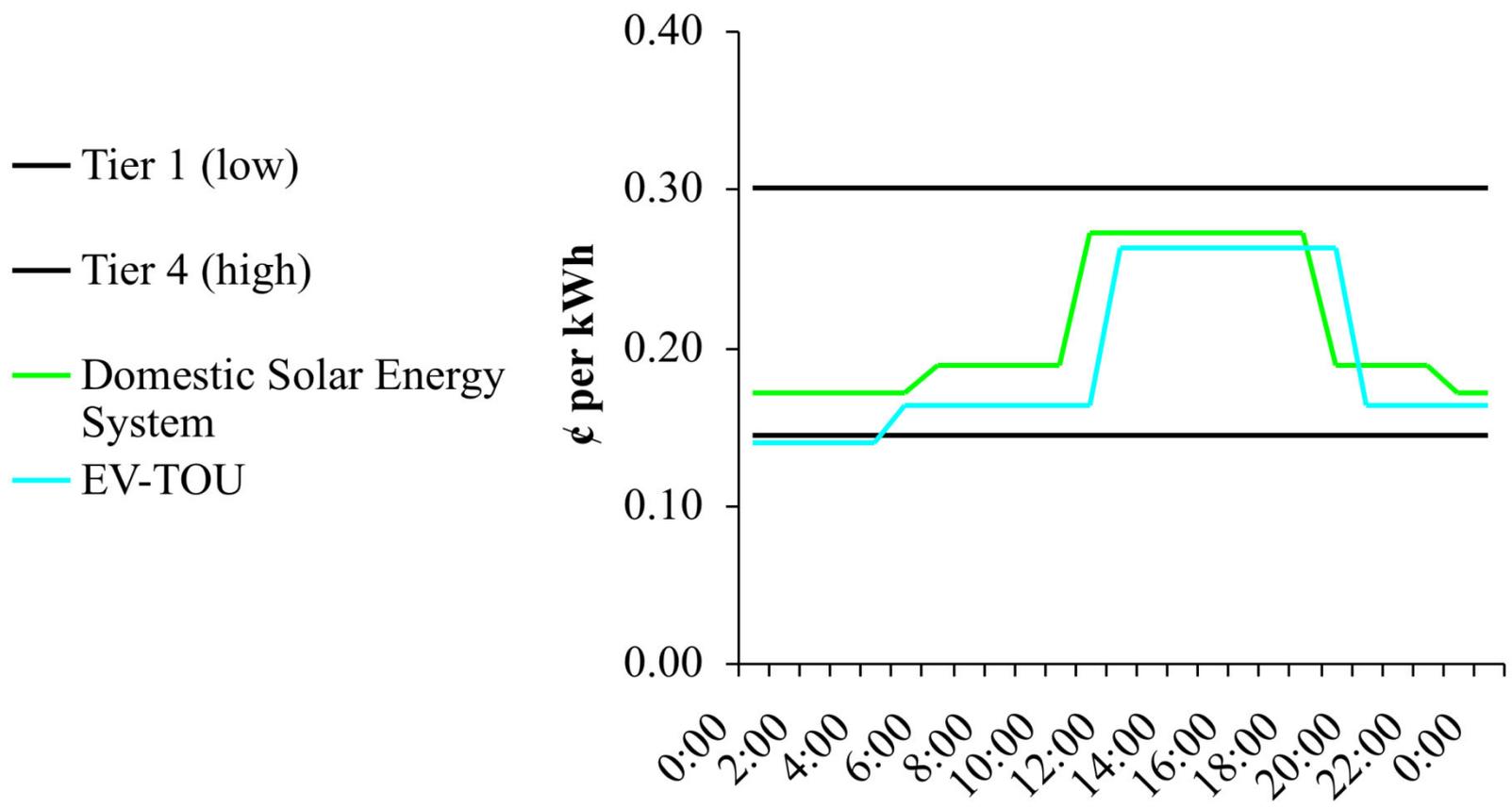


SDG&E Summer Experimental Tariffs



Do TOU tariff structures prompt the desired PEV demand profile?
Yes, but how small a price difference? Except...

SDG&E Summer DR-SES Tariffs



...households with SES generally report charging whenever they want: mental model that they are insulated from the grid

Public charging infrastructure is a new socio-technical system

- Technology, for example
 - Level 2 charging at destinations: a couple hours
 - DC Quick-charging along routes: 10-30 minutes
- New social relationships
 - Use shaped by etiquette, rules, laws—and assumptions
 - Failure to know these leads to
 - Less driving
 - Fewer charging events
 - Probably fewer charging events during the day than at night
 - Effect on total kWh less clear

Summary thoughts

- Initial evidence for variation between and within people in their PEV charging behavior
 - We have no comprehensive view of PEV charging
 - You can't observe serial correlation, e.g., non-random variation in the behavior of individual households over time, in one-day data
- Socio-technical systems are, to a degree, history dependent
 - Premature simplification has long term consequences, i.e., we should be most concerned with variability now
 - Corollary to historical dependence: Build the future you want and tell all the possible stories about it