



uplight

# Charged up and Ready to Roll

A Study of Differences in EV Charging Behavior  
across Residential Owners



# Intro & Context

# Uplight Team Introductions

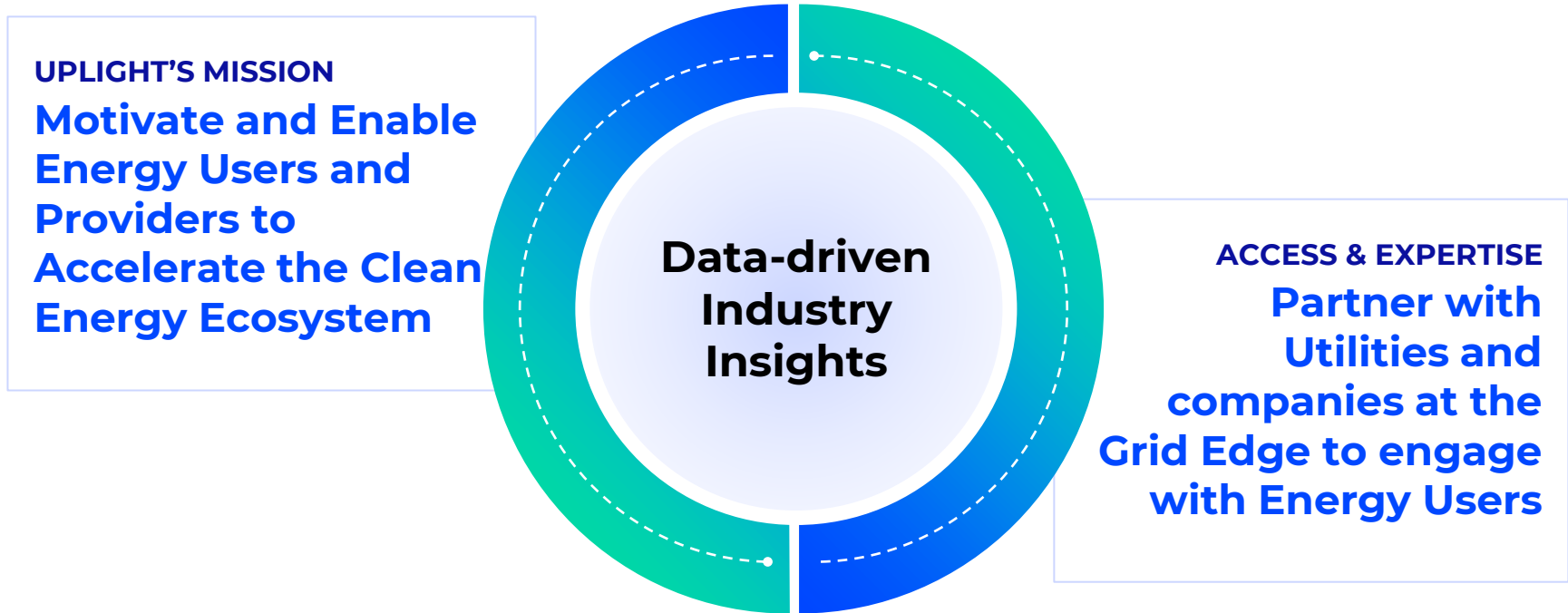


**Haley Northrup**  
Data Scientist



**Anna Gerngross**  
Senior Data Scientist

Uplight's goals, data access, and expertise uniquely enable data-driven industry insights.



# A study of at-home EV charging behavior + TOU program to provide insights that help inform how Utilities engage with EV users

## Rapid EV adoption

By 2030, 26.4 million electric vehicles (EVs) are projected in the U.S.

## Challenges for the Grid

A large number of EVs charging may present challenges for grid operation without updating grid infrastructure.

## Most EV charging occurs at home

88% of EV drivers surveyed report they primarily charge at home.

## Level 2 chargers have high power draw

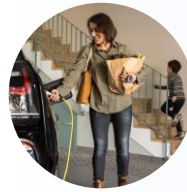
Level 2 chargers draw between 7 kW and 19 kW of power, much higher than other residential loads.

## TOU rates can shift load

Time-of-use\*\* (TOU) rates have been used to shift residential load to lower demand periods (off-peak).

\*\* TOU: Time-of-use pricing is an electric rate schedule that adjusts the price of electricity based on the time of day and or season.

This study looks at the intersection of EV charging behavior + TOU program to explore the following questions: →



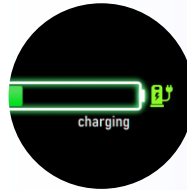
When do EV users plug-in and unplug their vehicles?



When do EVs start and stop charging?



How long are EVs left plugged in?



How long are EVs charging?



How does all of this relate to the TOU schedule?

# Data Summary

## Charging Data

- Over 1,000 Level 2 chargers
- 18 months of charging data
- About 70,000 weekday plug sessions

## TOU Schedule

### On Peak:

- Monday - Friday 7 am - 9 pm

### Off Peak:

- Monday - Friday 9 pm - 7 am
- All day Saturday, Sunday

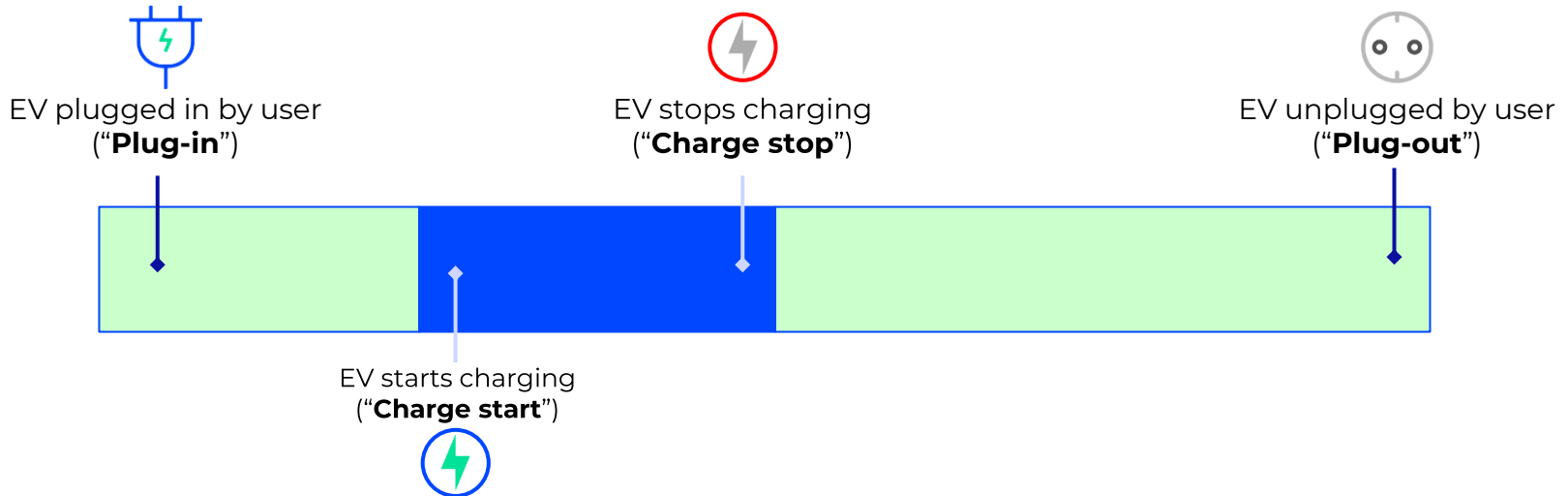
TOU schedule encourages shifting consumption on weekdays, therefore, our analysis focuses on weekday charging behavior.



There are two key concepts discussed in this study:  
a plug session and a charging period.

## PLUG SESSION: EV is connected to the charger

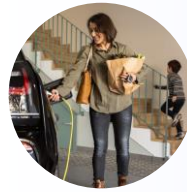
**Charging Period:** EV is actively charging and is contained within a plug session



# Outcomes

## Key Takeaways

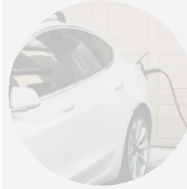
This study looks at the intersection of EV charging behavior + TOU program to explore the following questions:



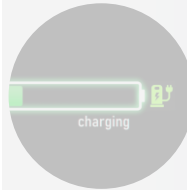
When do EV users plug-in and unplug their vehicles?



When do EVs start and stop charging?



How long are EVs left plugged in?



How long are EVs charging?

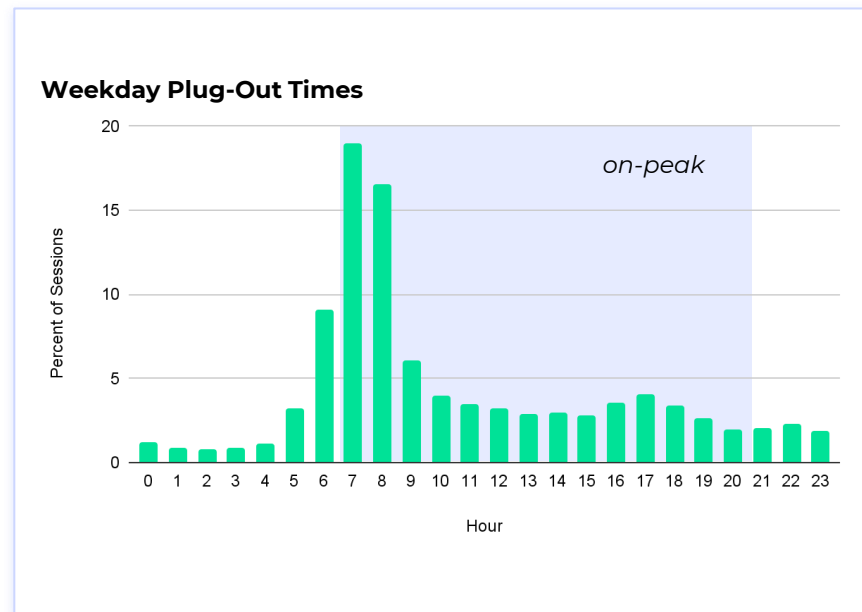
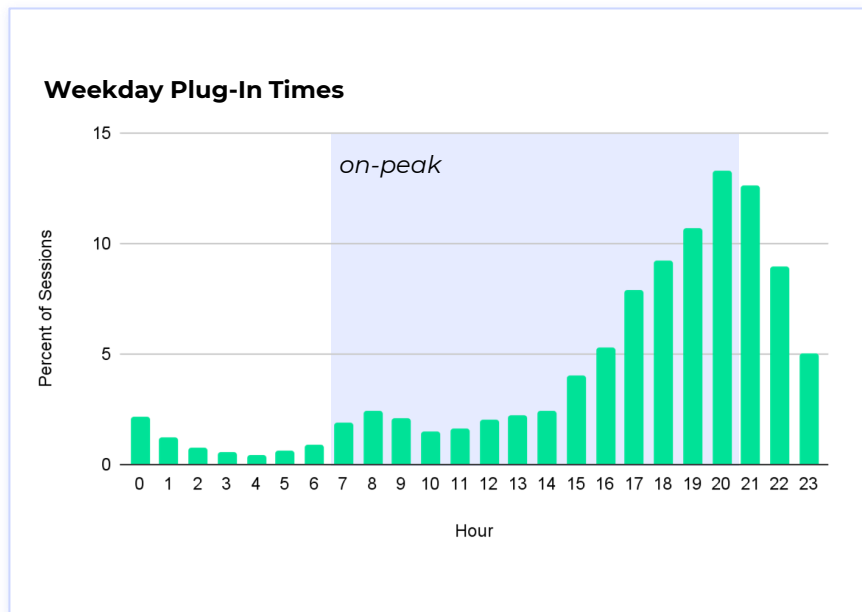


How does all of this relate to the TOU schedule?

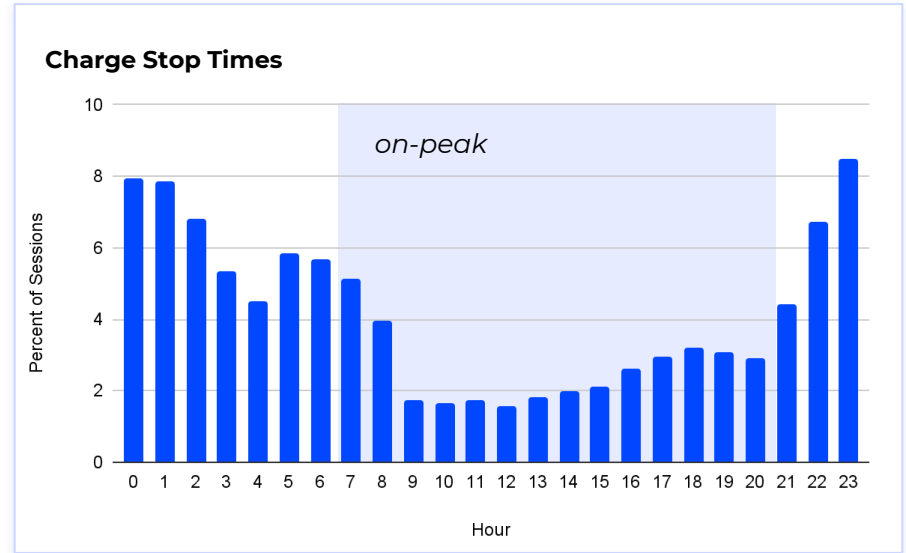
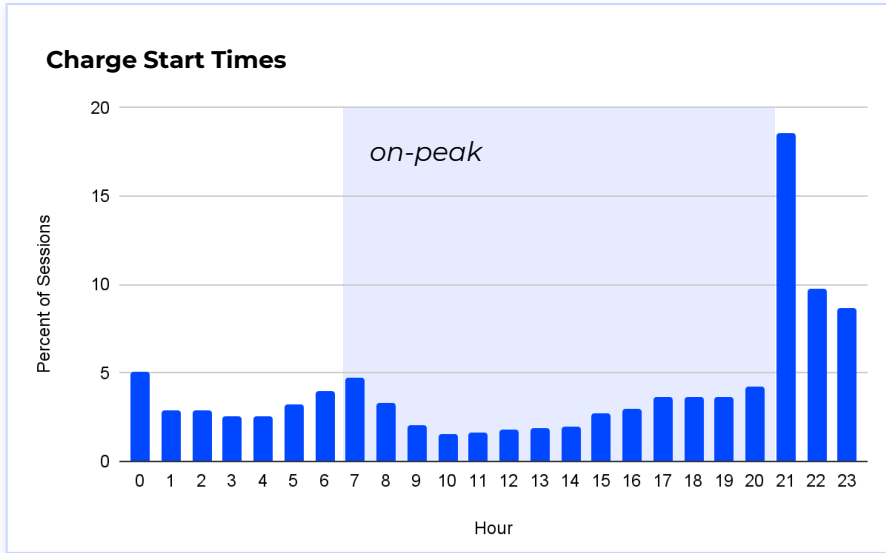
### Takeaway 1:

Trends indicate EV users in a TOU program charge their vehicles primarily during off-peak hours without changing when they plug-in or unplug their car.

# Plug-in/out is aligned with daily routine



# Charge start/stop is aligned with TOU program schedule.

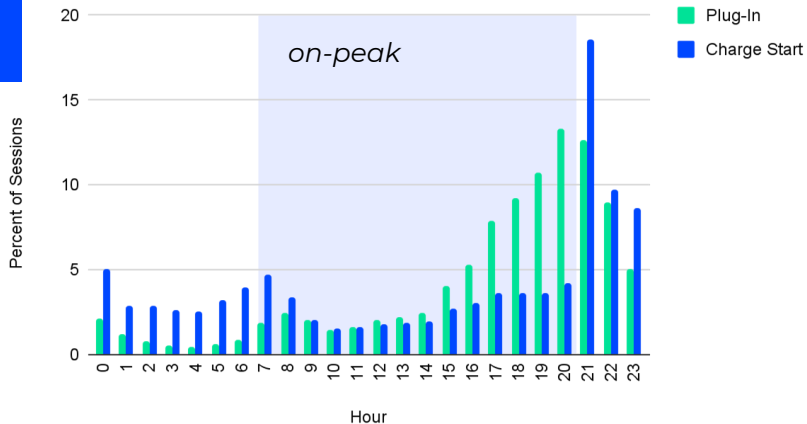


For 50% of sessions, charging is exclusively during the off-peak period

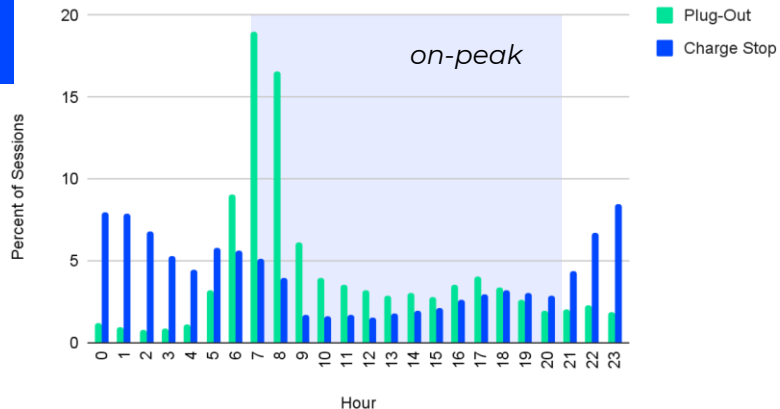
Plug in/out is aligned with daily routine while charging is aligned with TOU program

Shaded regions represent TOU on-peak period 7 am - 9 pm on weekdays.

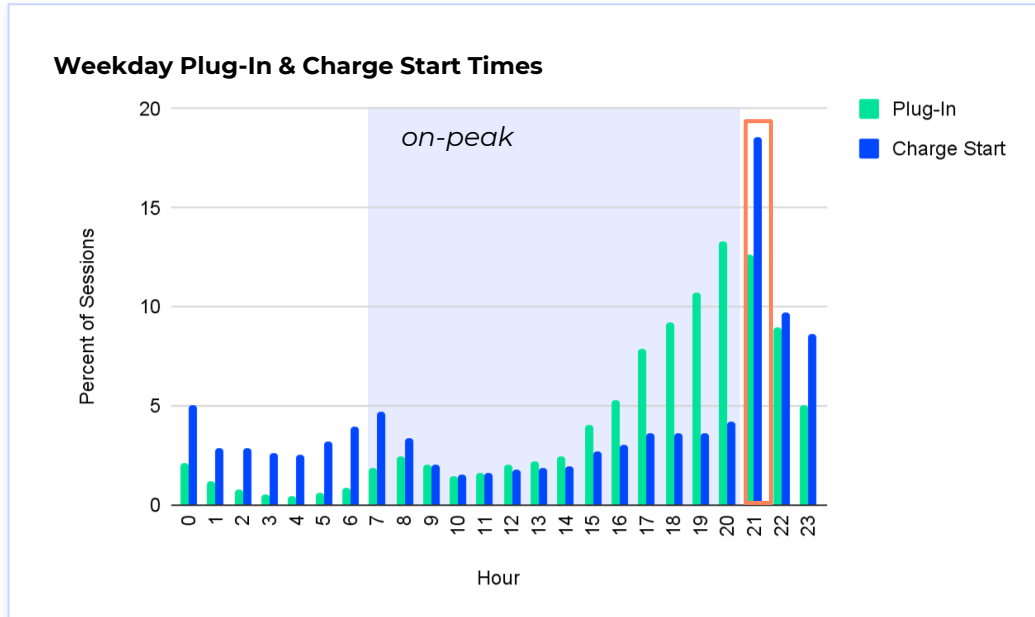
### Weekday Plug-In & Charge Start Times



### Weekday Plug-Out & Charge Stop Times



# Charge starts right after the off-peak period starts



Of sessions starting in 9-10 pm hour,

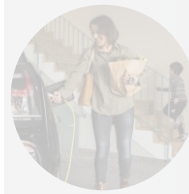
# 34%

of charging starts in the first minute of the hour.





This study looks at the intersection of EV charging behavior + TOU program to explore the following questions:



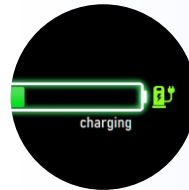
When do EV users plug-in and unplug their vehicles?



When do EVs start and stop charging?



How long are EVs left plugged in?



How long are EVs charging?



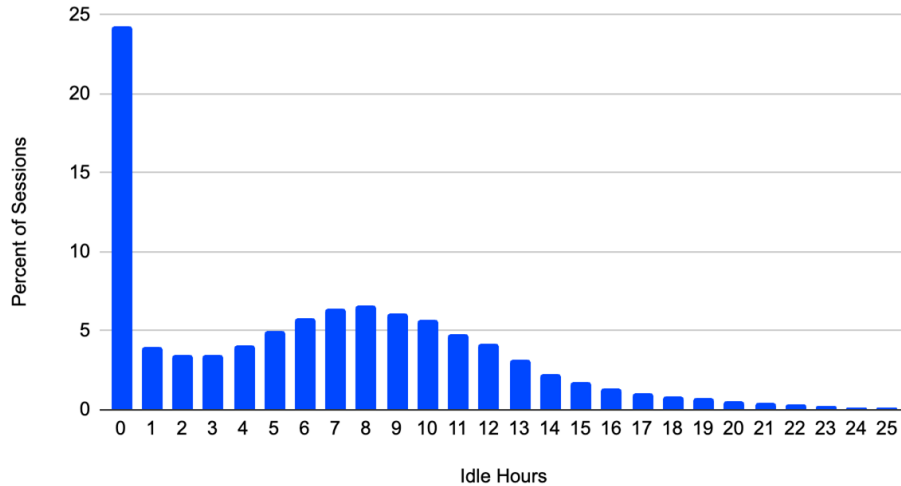
How does all of this relate to the TOU schedule?

## Takeaway 2:

EV user plug in/out behavior offers opportunity to shift EV charging load.

# Many sessions have multiple hours plugged in but not charging

## Idle Hours – Plug vs. Charge Duration Difference



**72%**  
of sessions



Plug-In

**2+**  
*Idle Hours*



Plug-Out

**44%**  
of sessions



Plug-In

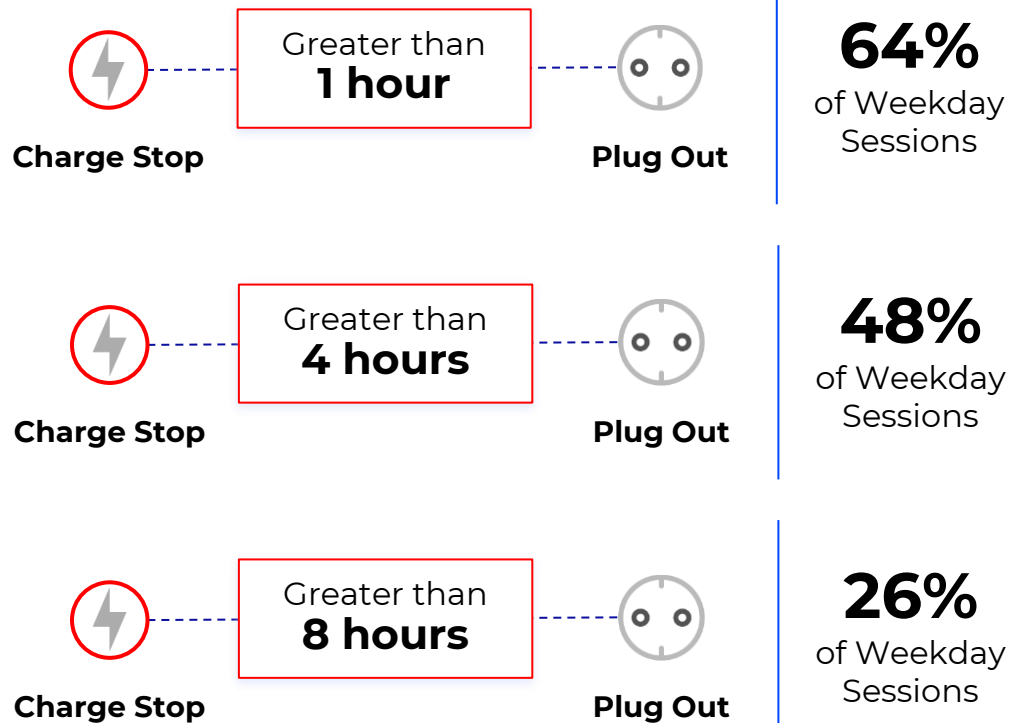
**8+**  
*Idle Hours*



Plug-Out

Even for TOU, many sessions have extra hours after charging is complete.

## Time between Charge Stop and Plug Out



# Discussion

# Summary

## The EV TOU Program is effective but may present challenges

- Most charging occurs off-peak
- Many sessions start immediately after the off-peak period begins.
- Concentrated EV charging right after the TOU off-peak period begins could cause issues for the grid.

## Residential EV charging is flexible

- The length of time an EV user is plugged in at home is often more than is needed to charge.
- The EV charging time could be shifted around while the EV is plugged in and still within TOU off-peak period.

# Opportunities for Utilities

## Passive Managed Charging

- Behavioral-based incentives and rates
  - Charging Incentives
  - TOU Rates for EVs

## Active Managed Charging

- Direct control of EV chargers
  - Event-based
  - Daily optimization

## Stacked Solutions

- Combined approach using passive and active solutions

# Backup



Even when  
plug in / plug  
out times  
change -  
charging still  
happens  
around 9pm

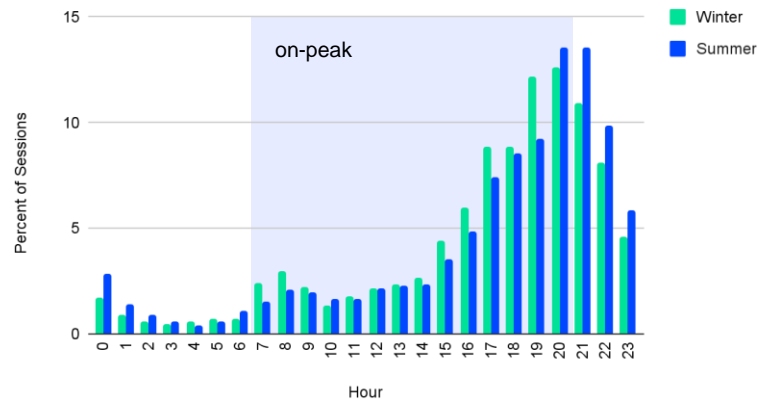
## Plug in

Shift in plug in  
start with time  
of year - earlier  
in the day as  
get home  
earlier

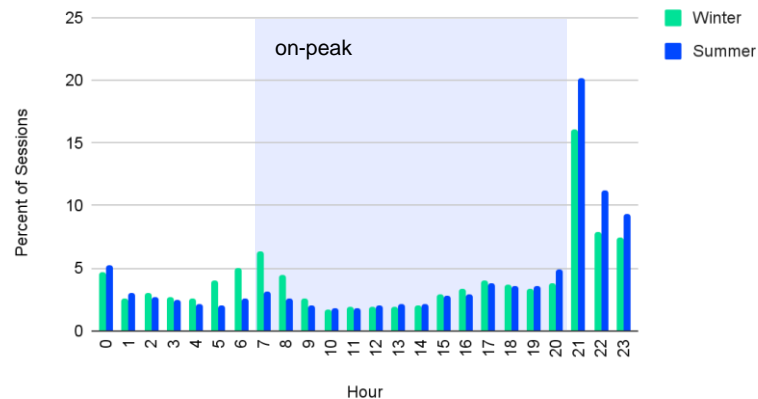
## Charge Start

Charge start  
still tends  
toward 9 PM

Plug-In Time Winter vs. Summer



Charge Start Time Winter vs. Summer



Shaded regions represent TOU on-peak period 7 am - 9 pm on weekdays.