



Lawrence Berkeley National Laboratory  
Environmental Energy Technologies  
Division **Behavior Analytics**  
*Providing insights that enable evidence-based, data-driven decisions*

# **Insights on Home Energy Reports from Smart Meter Data Analytics**

***A National Summit on Smart Grid  
and Climate Change***

Peter Cappers

December 2, 2014

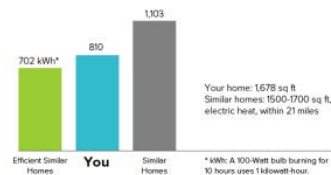


# Data “explosion” in energy

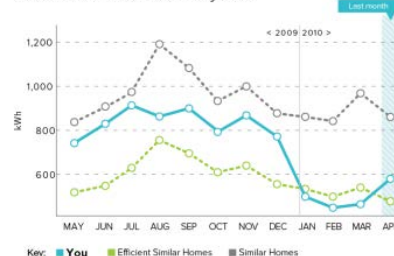
- Smart meters, thermostats, appliances, cars
- Linked to other time and location-specific information (temperature, census, satellite)
- Provide vast, constantly growing streams of rich data that can be used in novel ways



Last Month Electricity Use



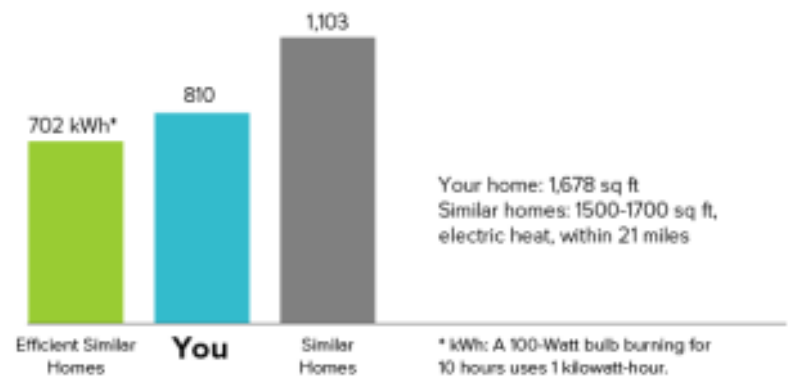
Last 12 Months Electricity Use



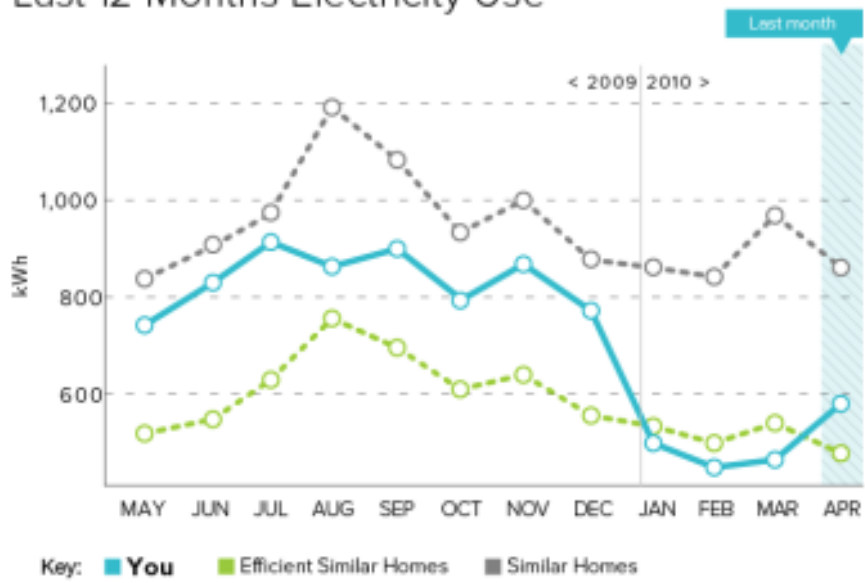


# What is a HER program?

## Last Month Electricity Use



## Last 12 Months Electricity Use



### Welcome to your first home energy report.

This report is part of a free program to help you save money and energy.

### How you're doing:

Great 😊 😊  
**Good** 😊

Using more than average

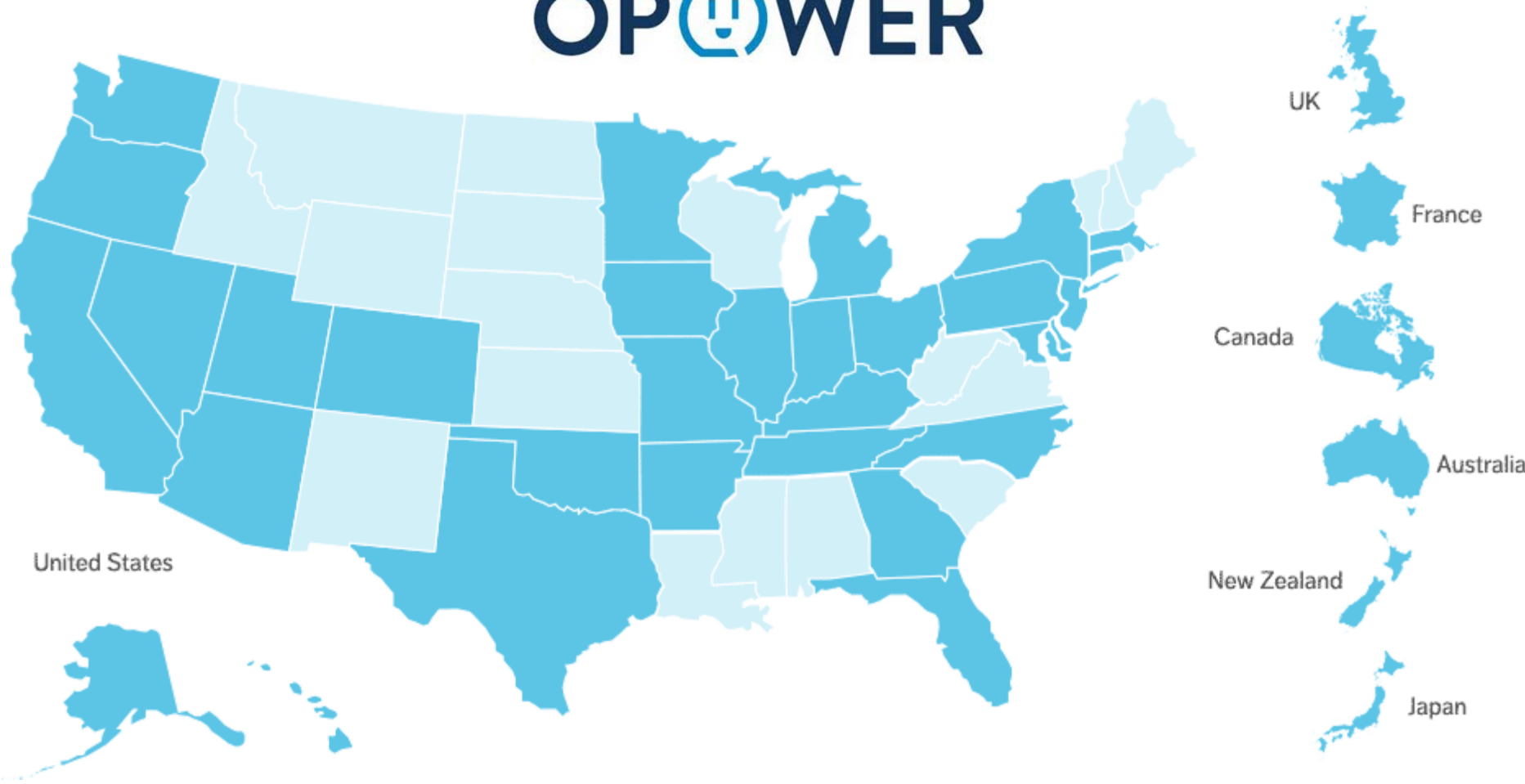
**i** We estimate that you could **save \$150** each year.

Turn over for ways to save ➡



# Explosion in the use of HER Programs

## OP@WER



# Outstanding Issues with HER Programs



- **What time of day are the savings generally occurring in?**
- **What types of actions generate the savings?**
- **How soon after delivery of HERs do the savings begin?**
- **Are those savings maintained between delivery of HERs?**
- **Are the savings from HERs persistent over time?**



# Data description

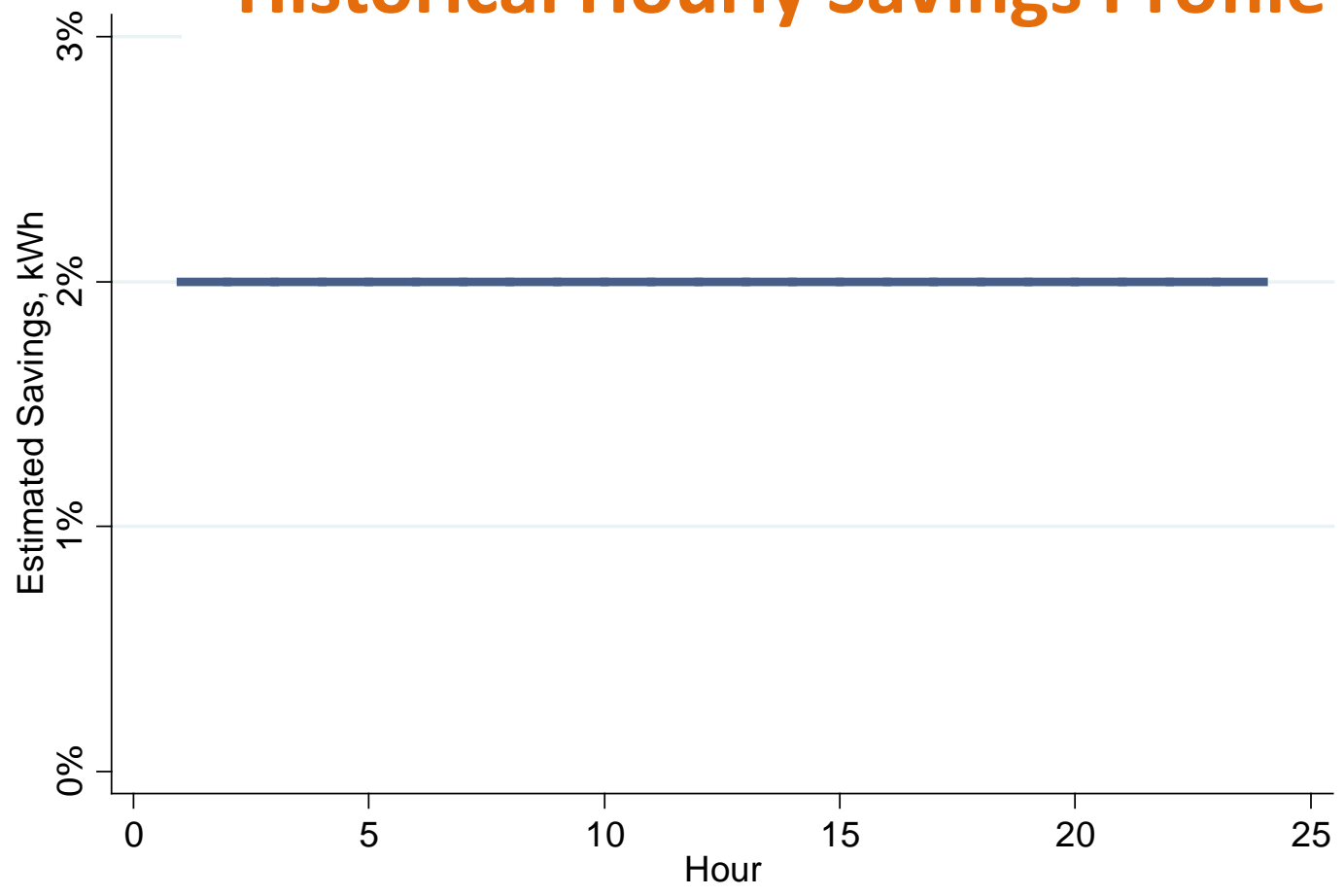
- HER program implemented as a “randomized controlled trial”
- Hourly electricity data from Pacific Gas & Electric’s (PG&E) AMI system
- Two datasets from different rollouts (“waves”)

	# Treat	# Control	Launch Date	Hourly interval data available	PG&E baseline territory	Quartile of energy use
Wave One	400,000	100,000	Feb 2012	Aug 1, 2012- Oct 31, 2012	P, Q, R, S, T, V, W, X, Y	Top 3 quartiles
Gamma Wave	72,300	72,300	Nov 2011	Nov 4, 2011- Aug 1, 2012	R, S, T, W, X	All quartiles



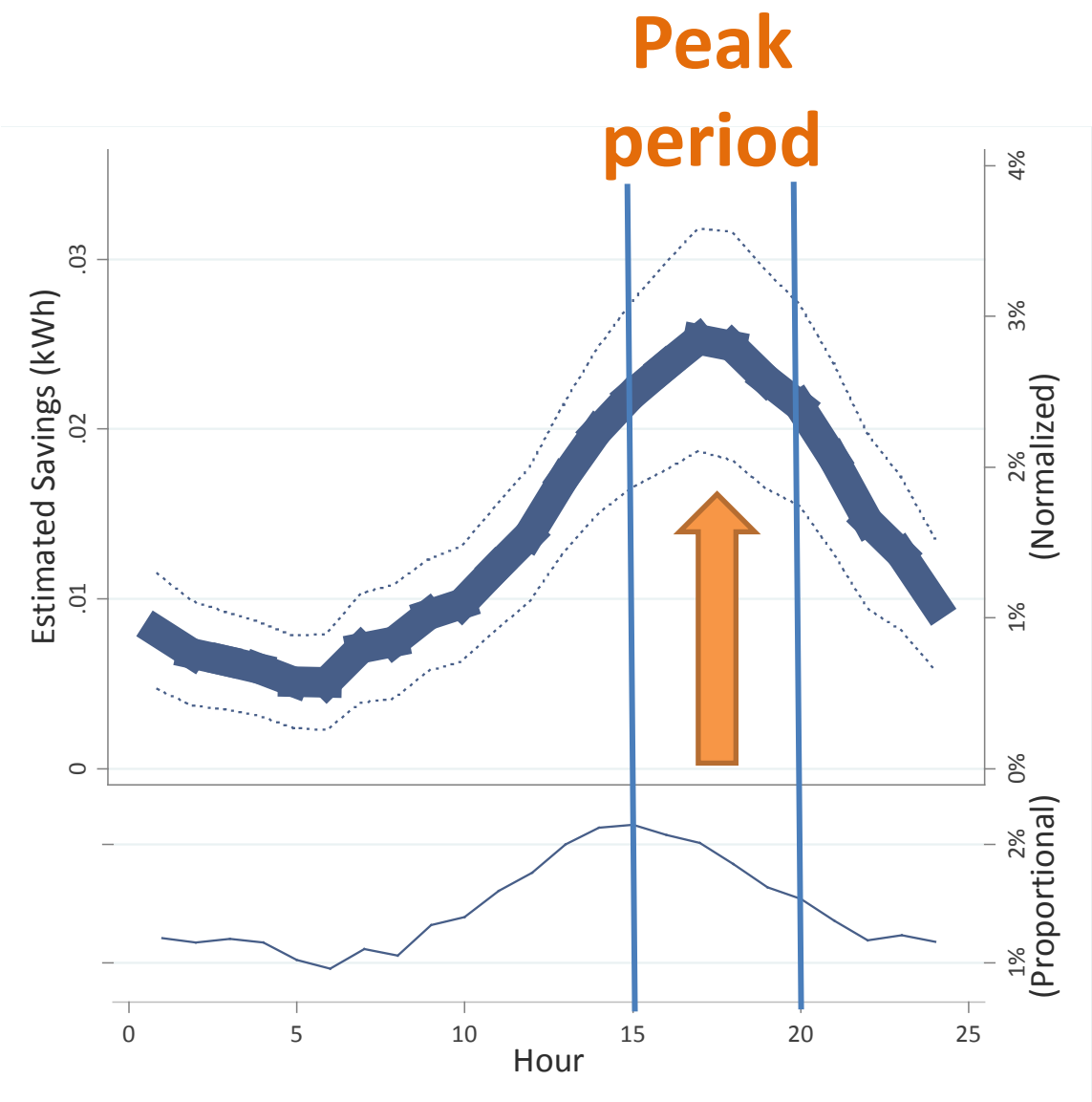
# Absent Smart Meter data, savings from HER presumed constant over all hours

## Historical Hourly Savings Profile





# Hour-by-hour savings estimates now possible with Smart Meters

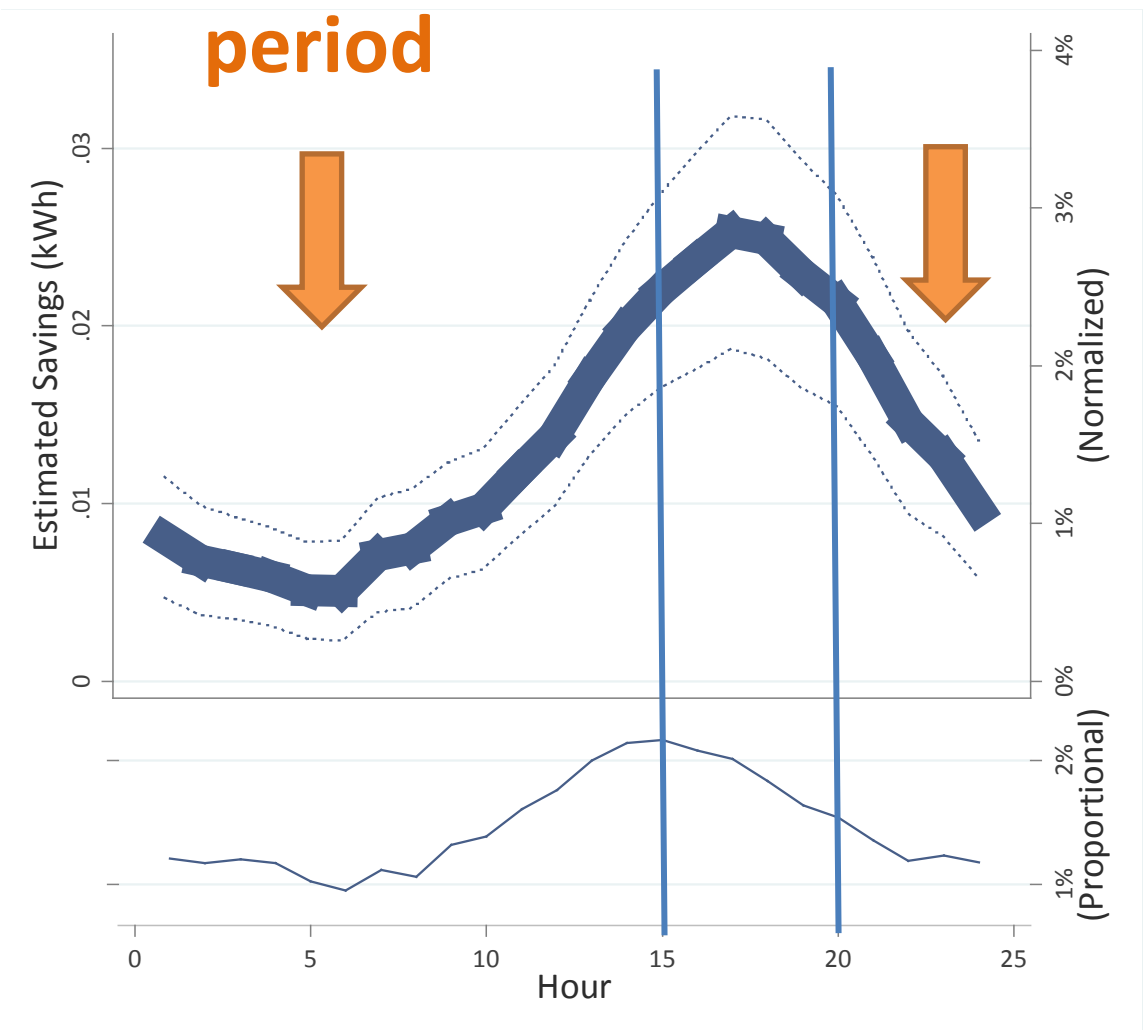






# Hour-by-hour savings estimates now available with Smart Meters

Off-Peak period

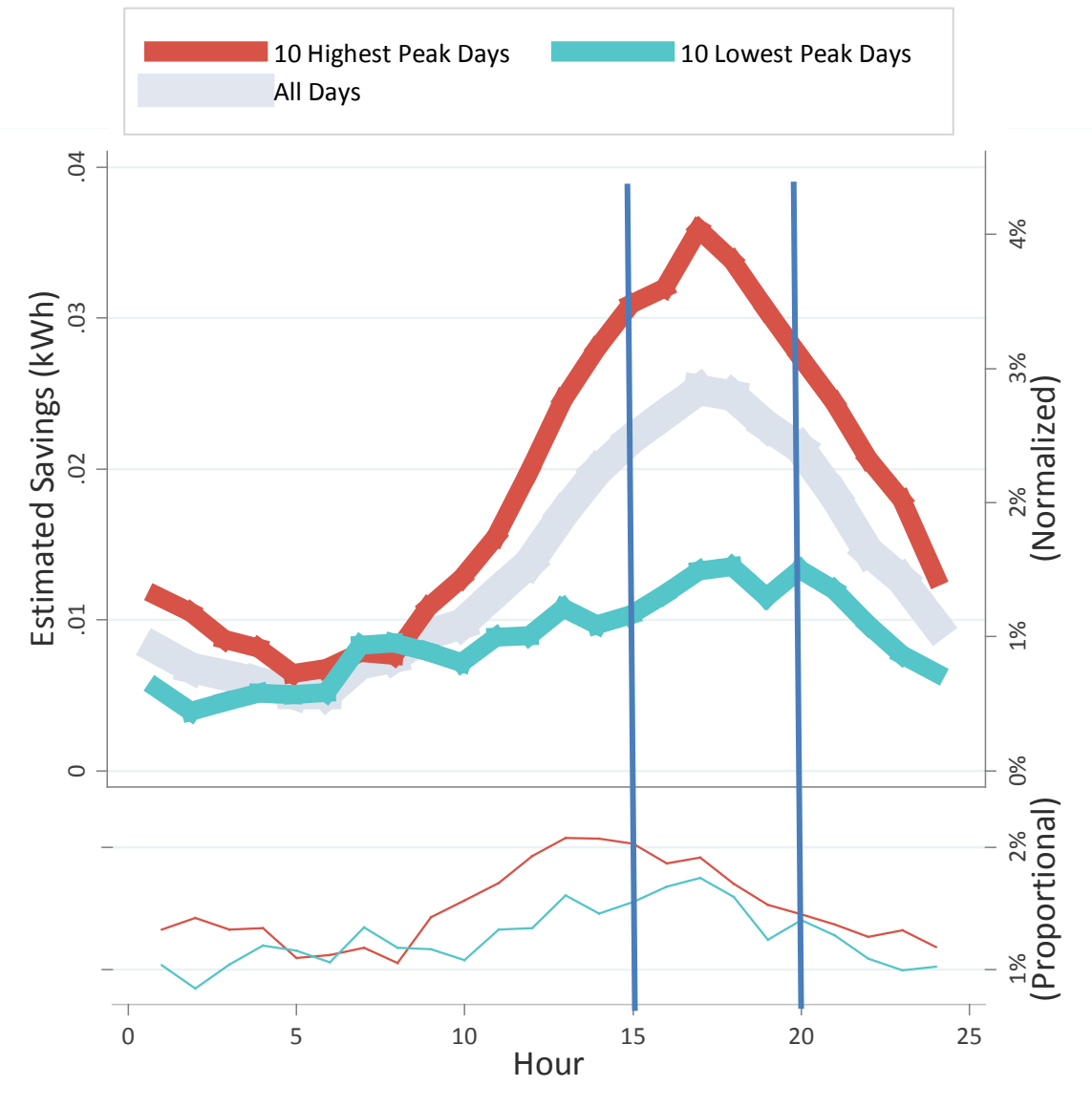




# Hour-by-hour savings estimates now available with Smart Meters

Larger savings on highest peak demand days

Smaller savings on lowest peak demand days

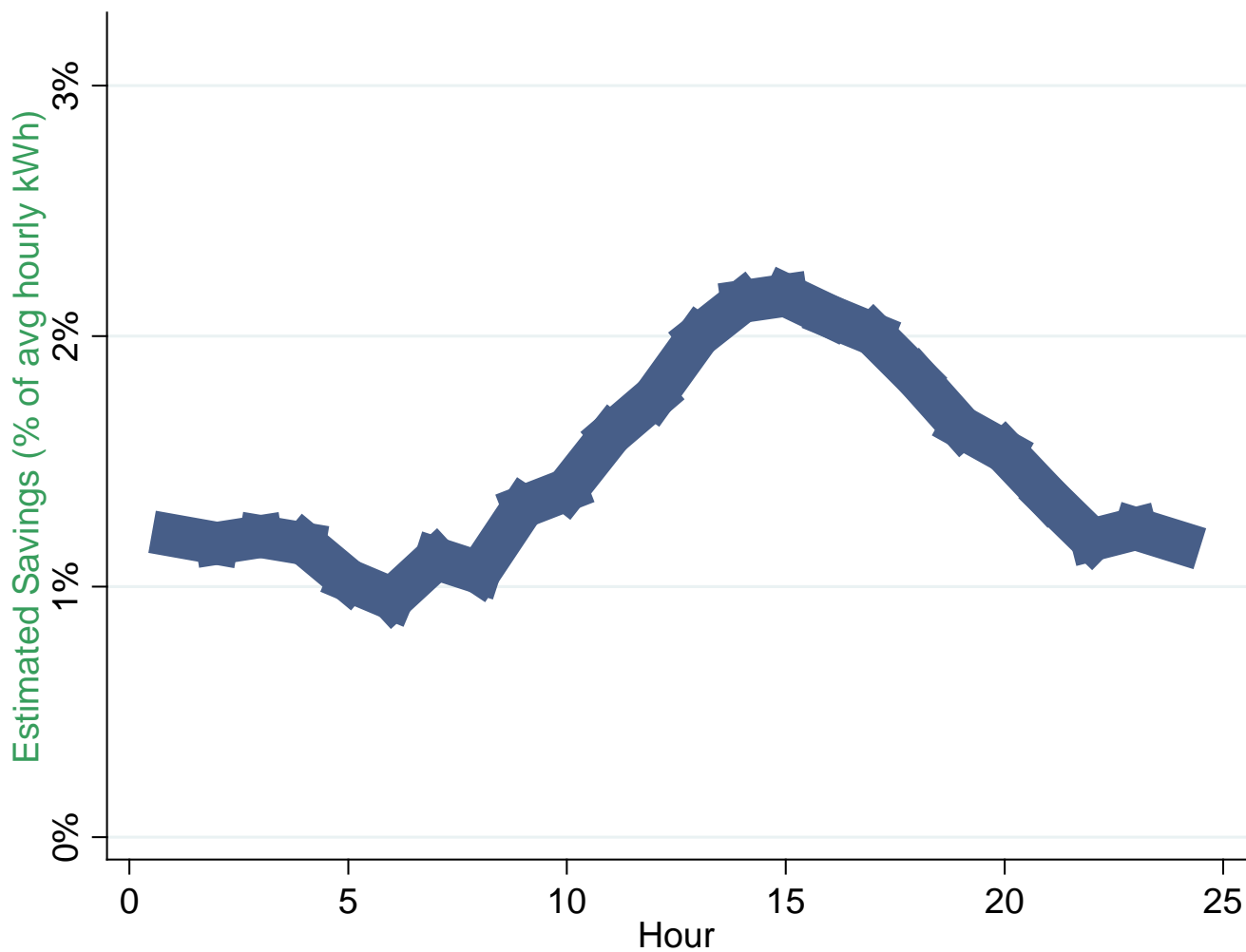


# Estimates of actions generating savings now available with Smart Meters



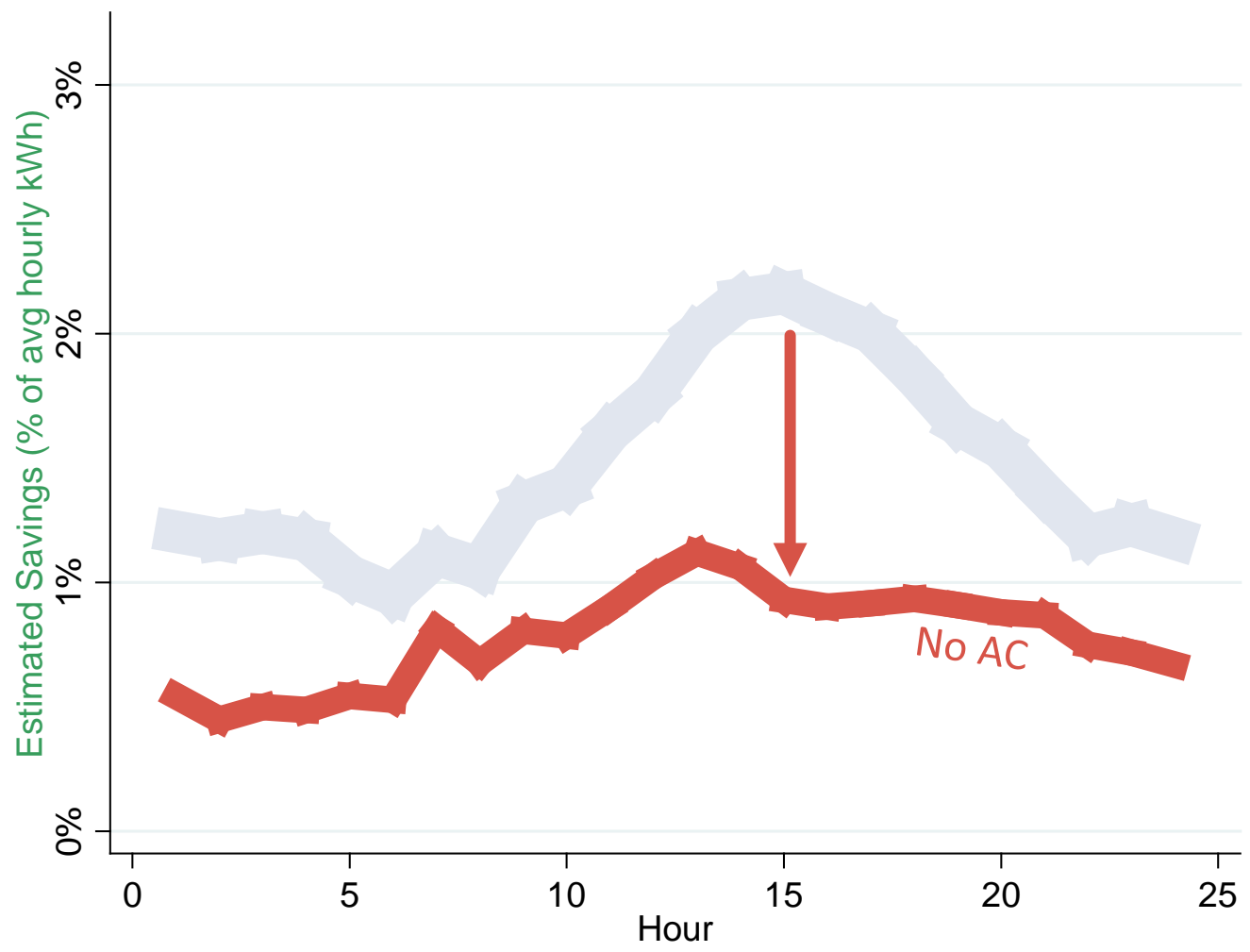
- In PG&E's service territory, the highest demand levels occurs on days that are very hot whereas the lowest demand days are usually much cooler
- AC use is correlated with high temperatures and can be relatively easily discerned from an analysis of a load profile

# Estimates of actions generating savings now available with Smart Meters



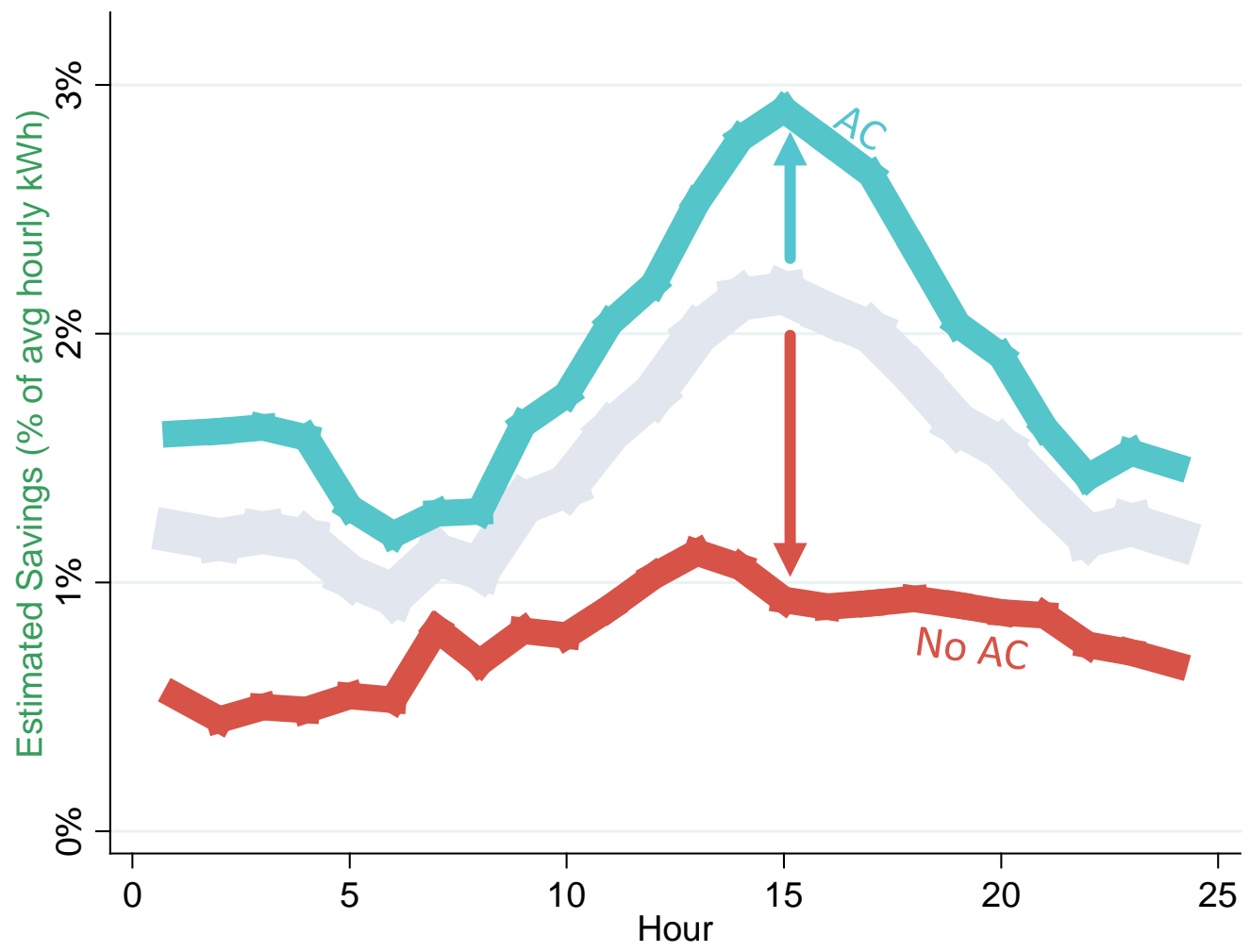


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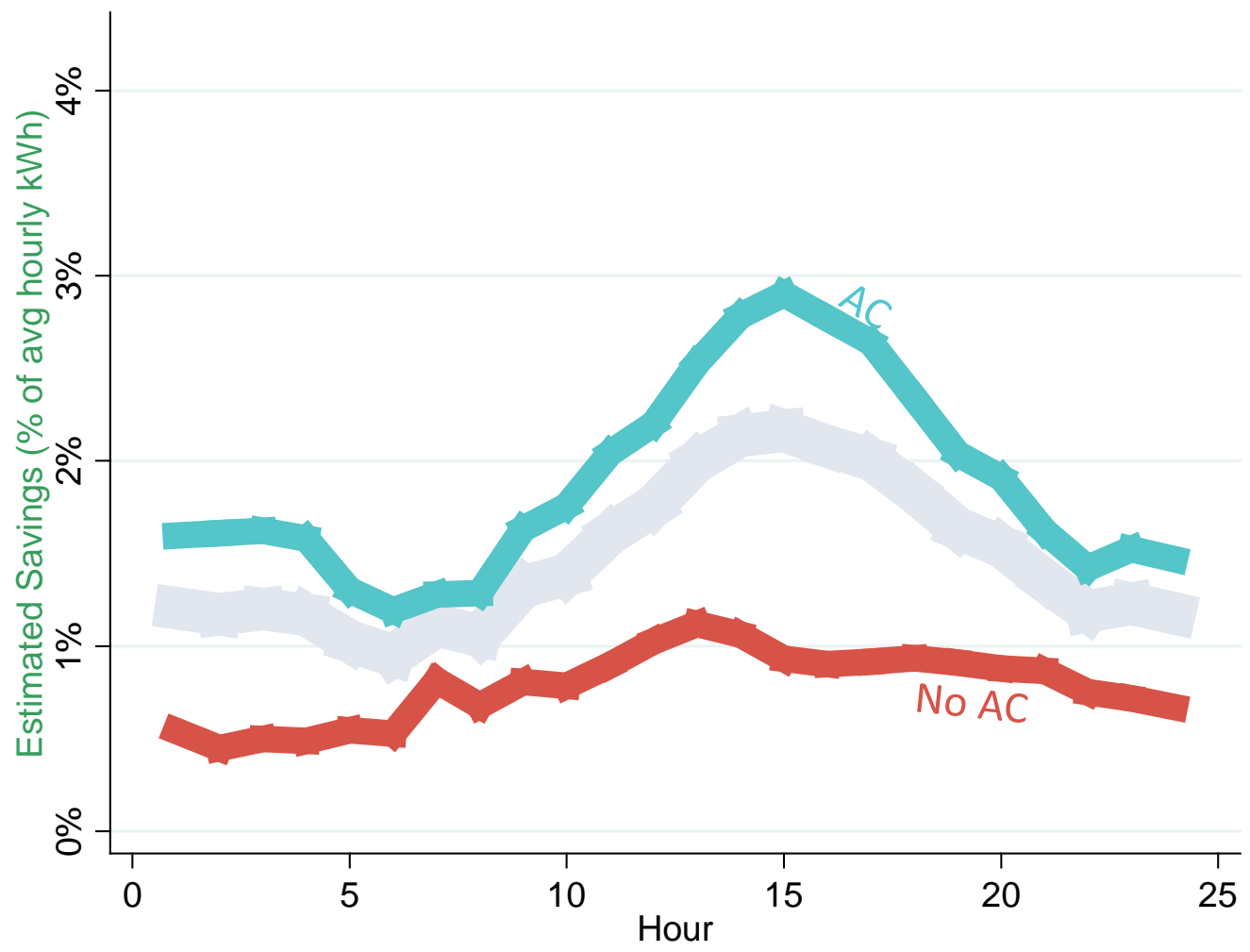


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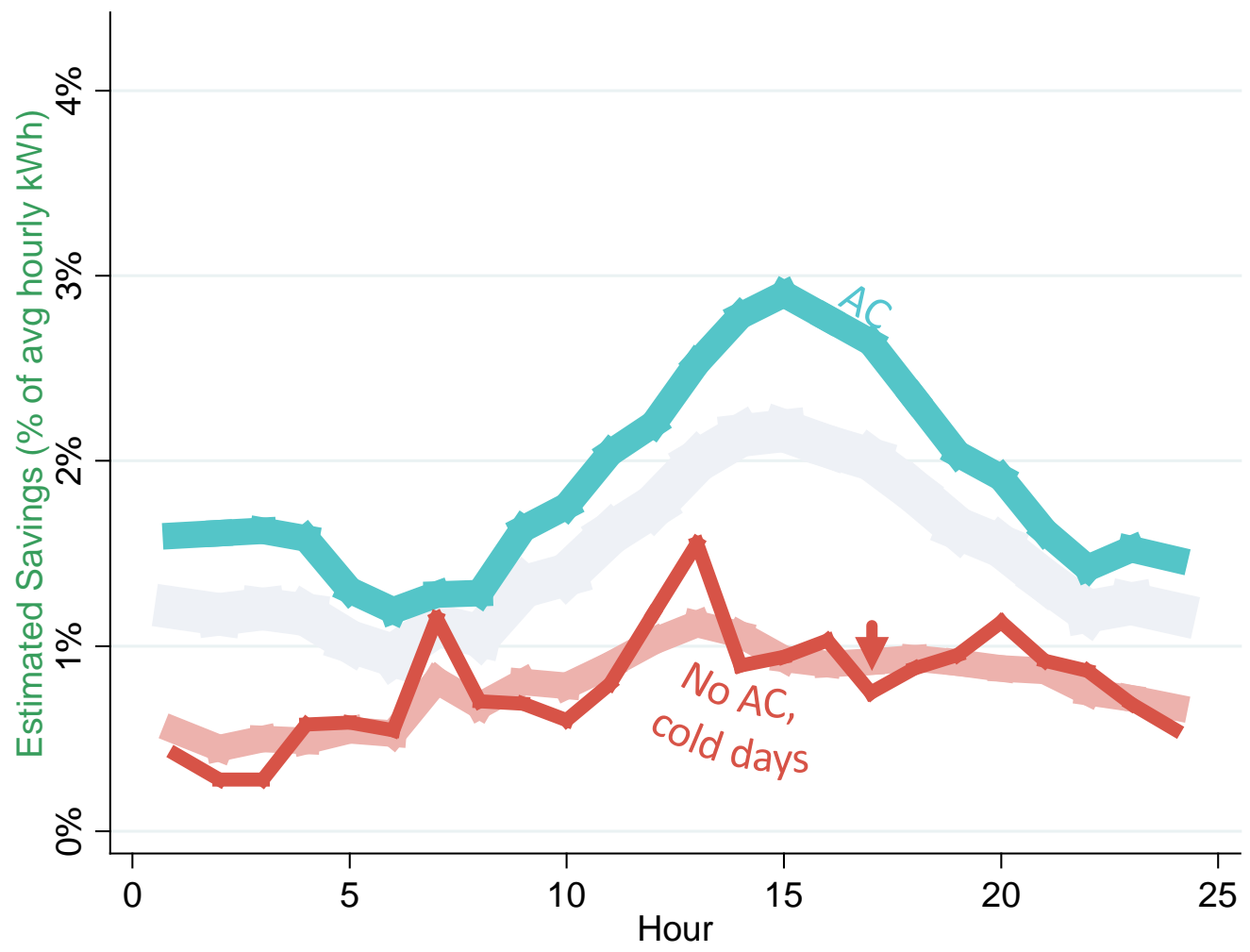


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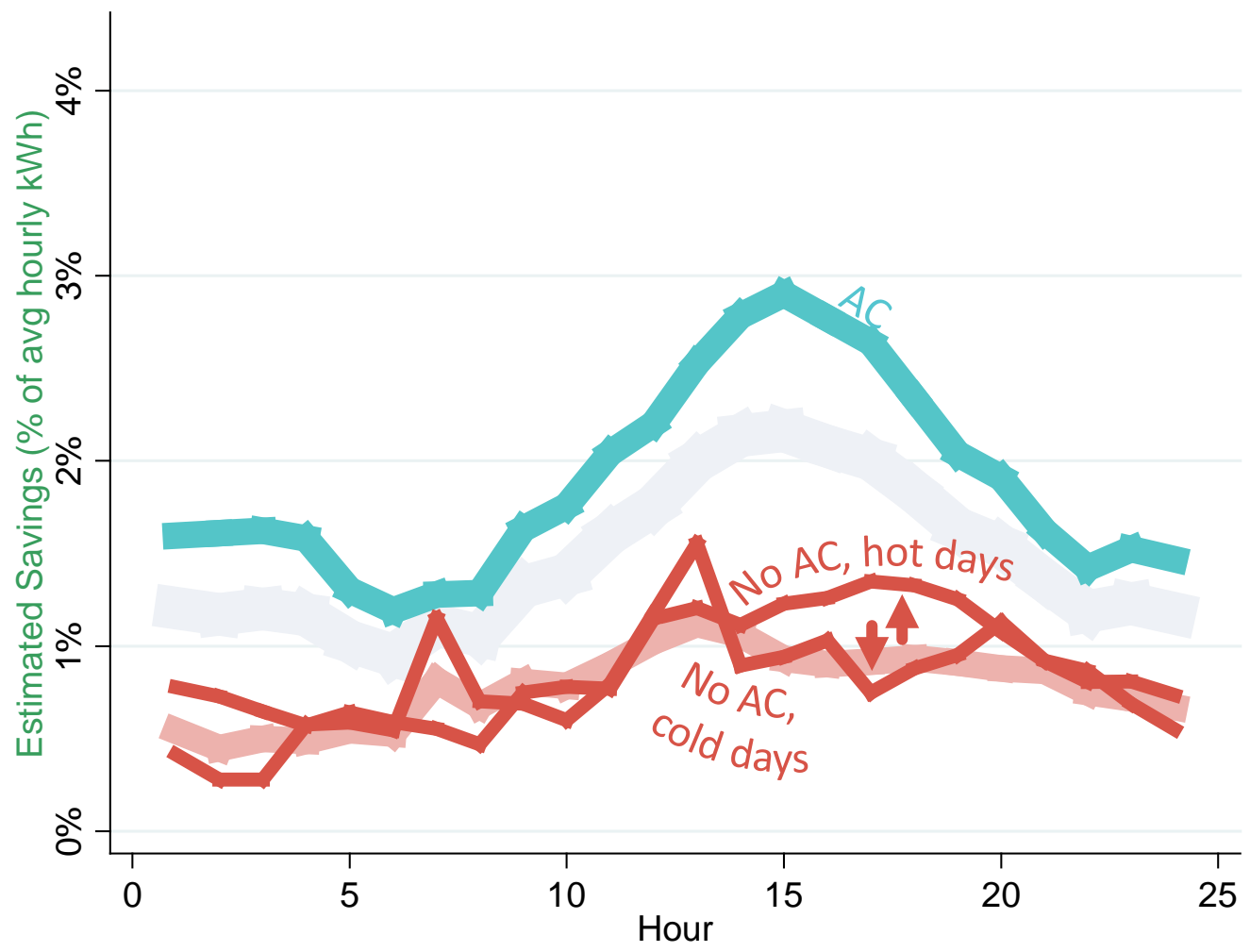
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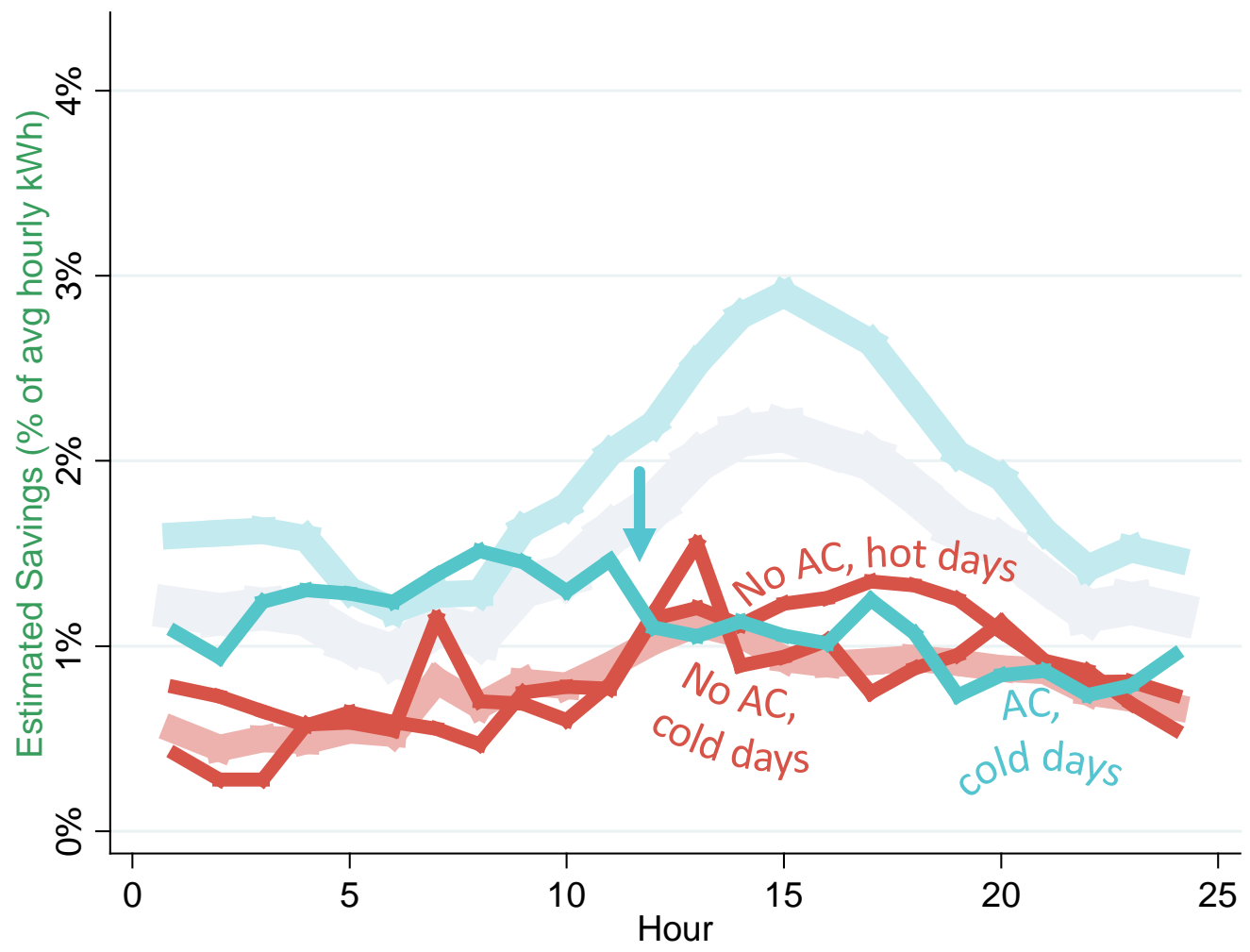


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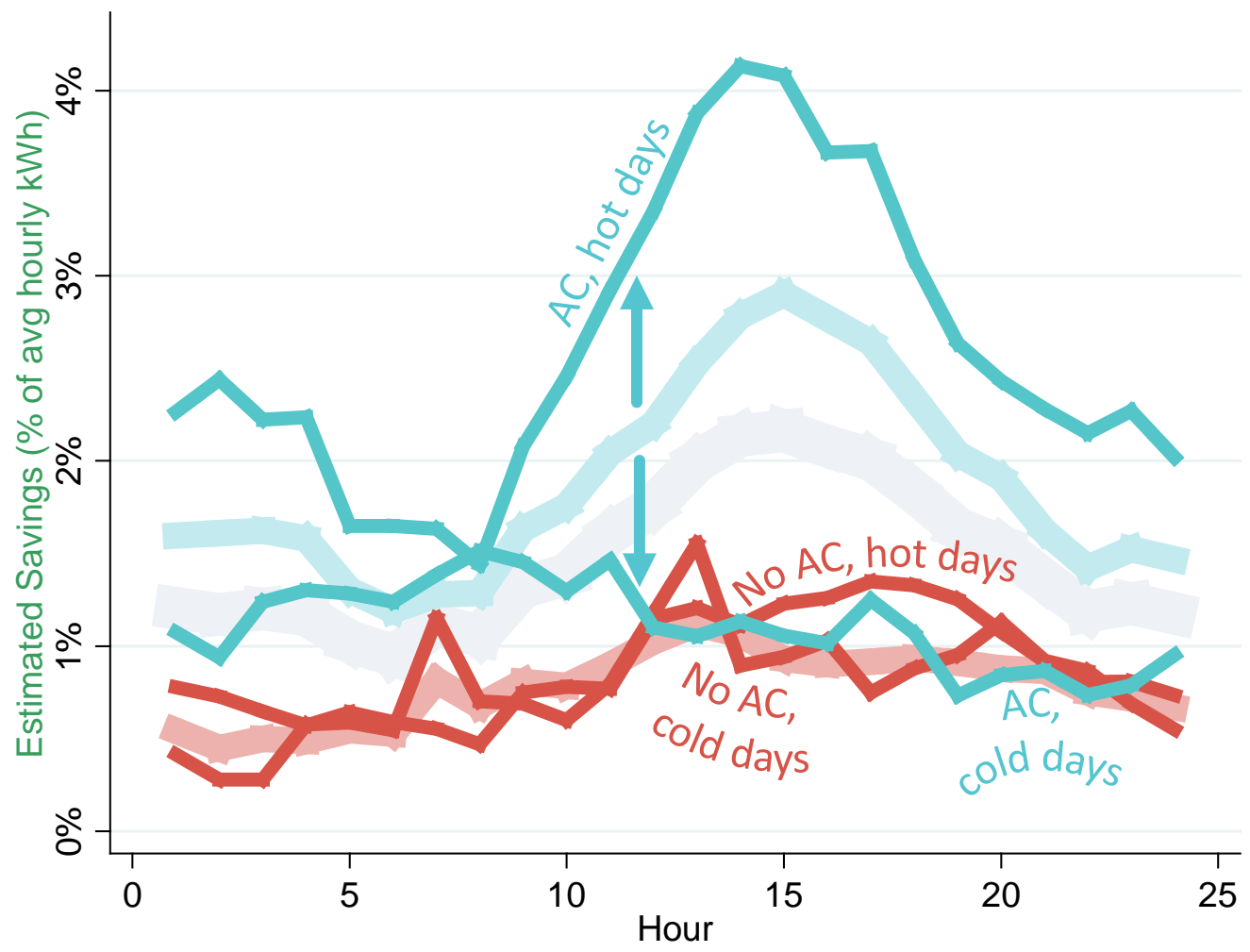


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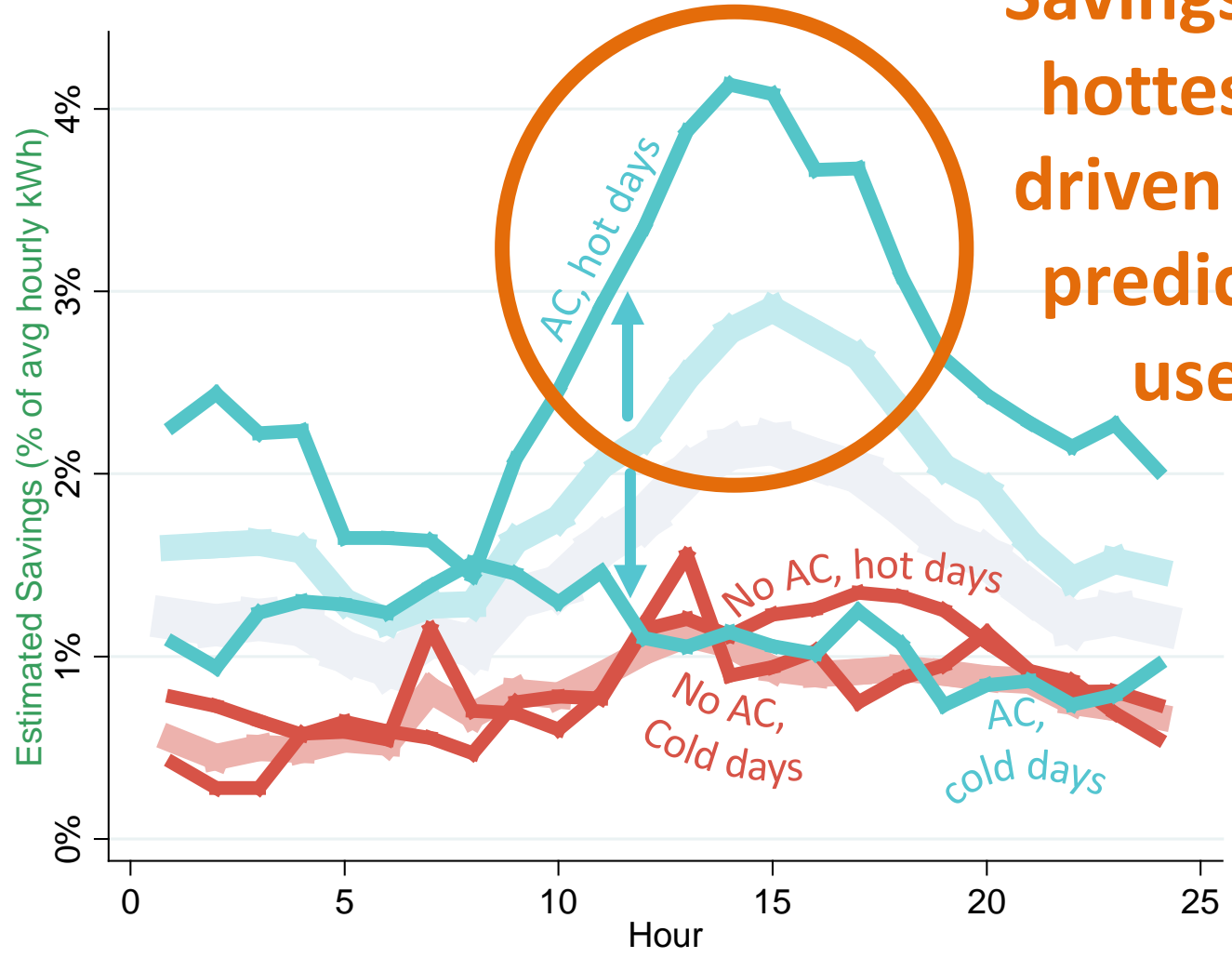
# Estimates of actions generating savings now available with Smart Meters





# Estimates of actions generating savings now available with Smart Meters

Savings on the hottest days driven by HHs predicted to use AC



Best guess – change AC settings

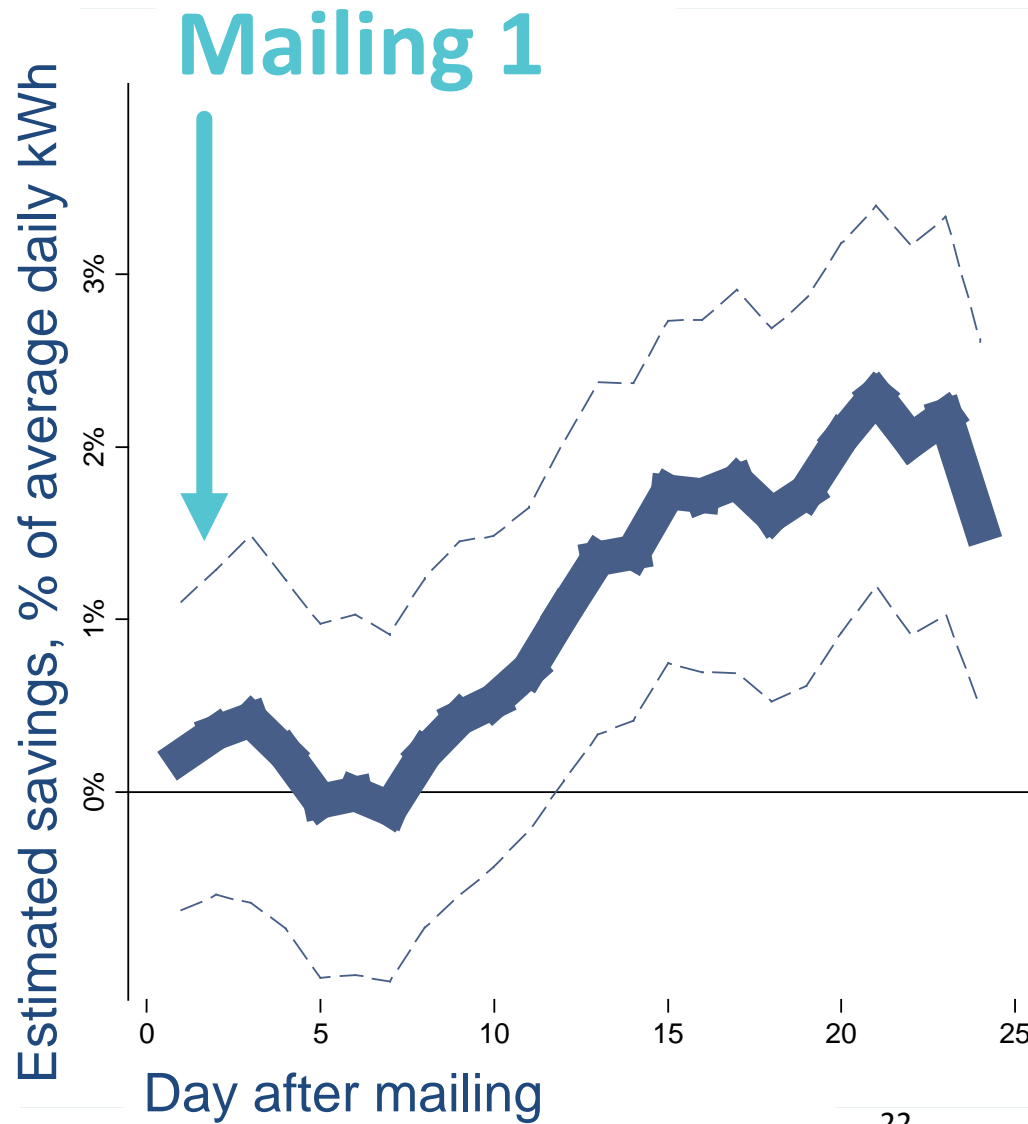


# Timing of when savings occur after HERs delivered now possible with Smart Meter

- **Interval smart meter data can be used to assess:**
  - **How quickly after the initial delivery of the HER residential customers change their electricity consumption behavior?**
  - **If savings continue between HER deliveries?**
  - **If savings decay between HER deliveries?**
  - **If savings are consistent across all days between HER deliveries?**
  - **If savings change upon receipt of subsequent HERs?**

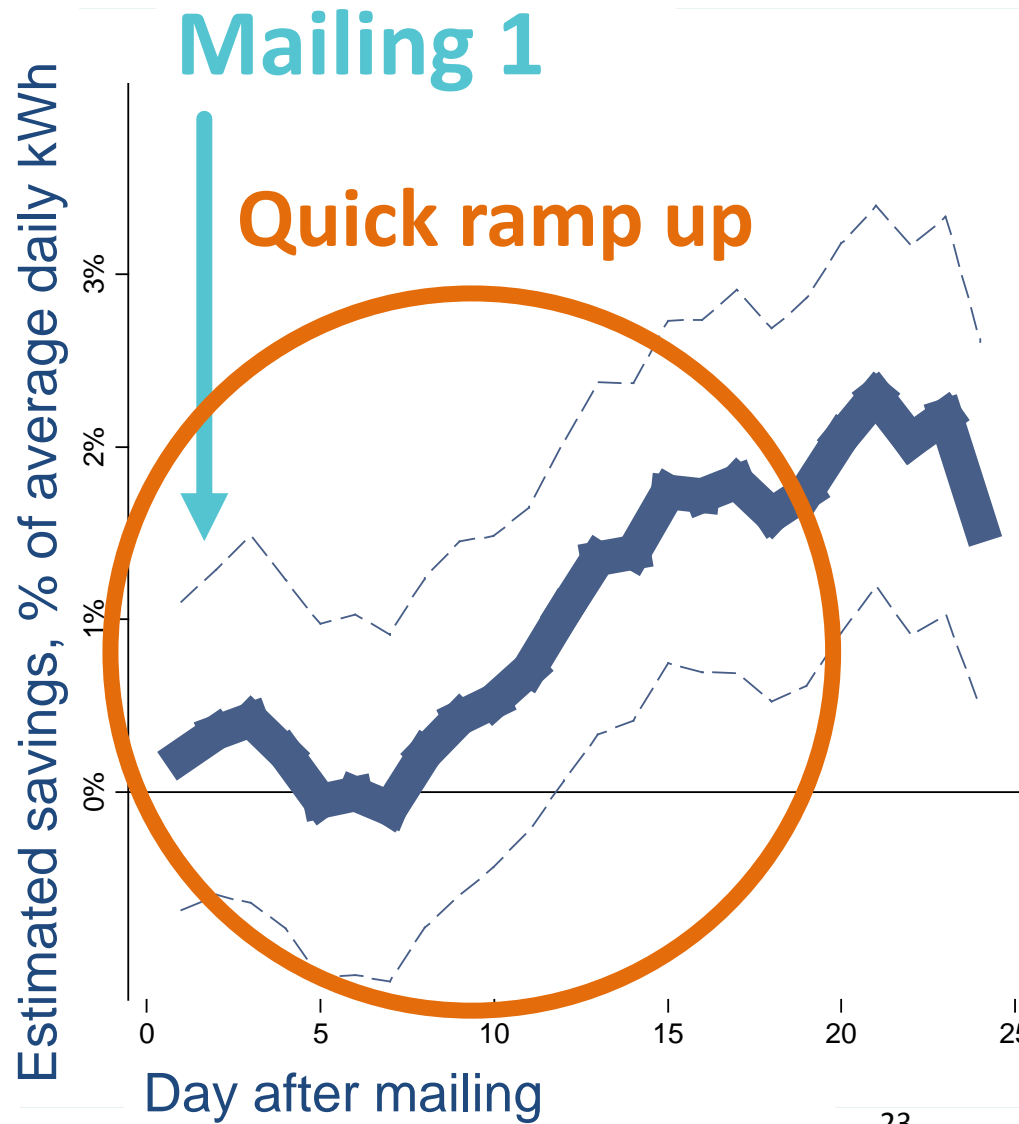


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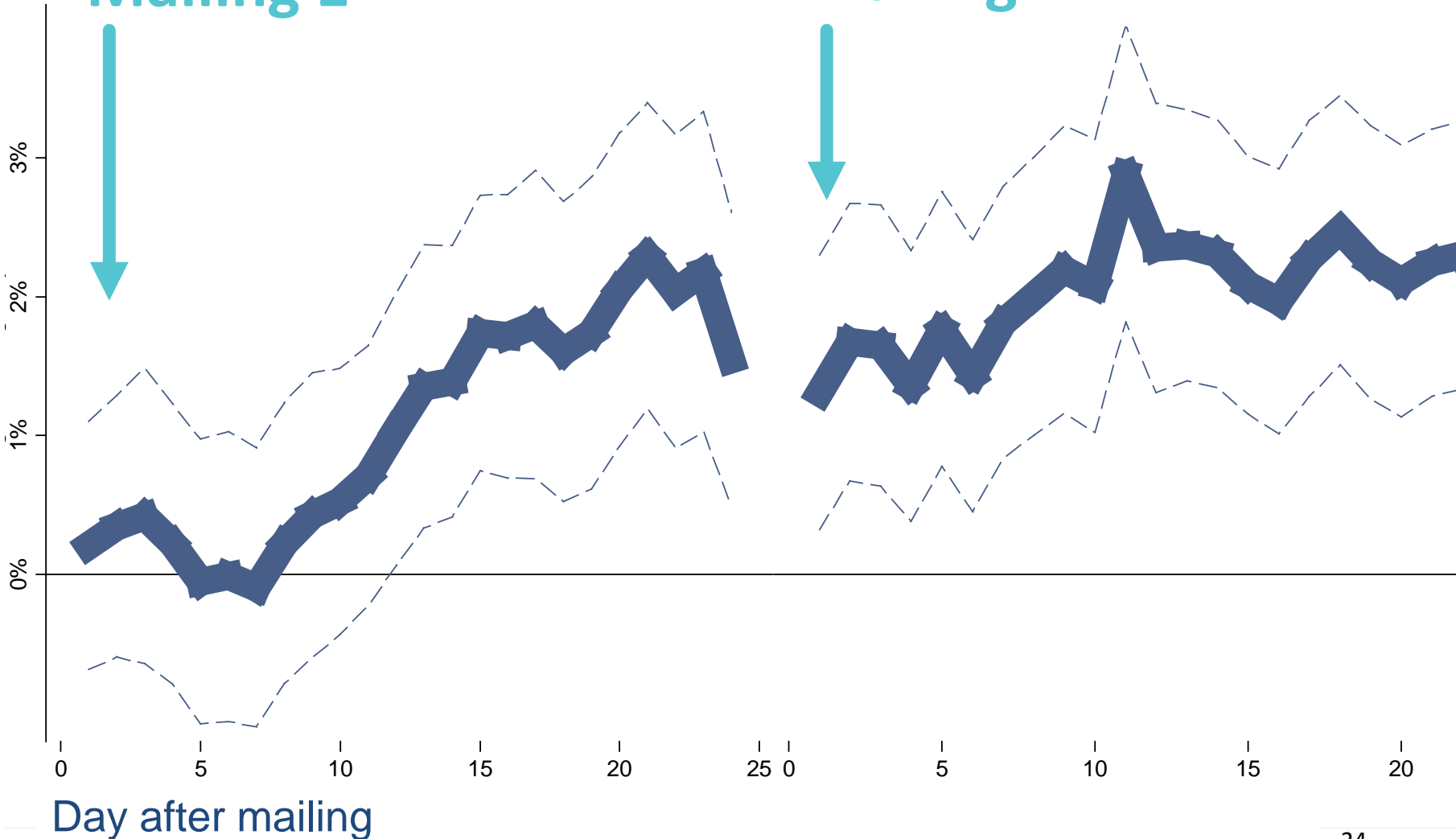
# Timing of when savings occur after HERs delivered now possible with Smart Meter



Mailing 1

Mailing 2

Estimated savings, % of average daily kWh

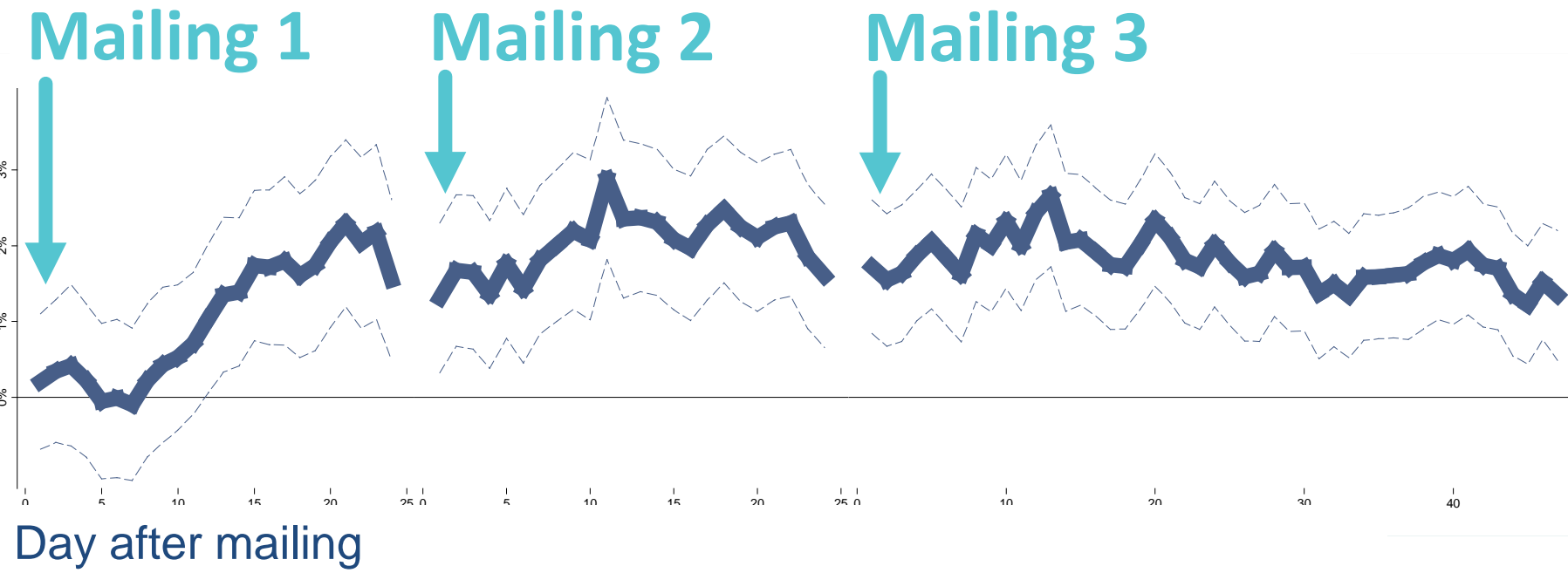






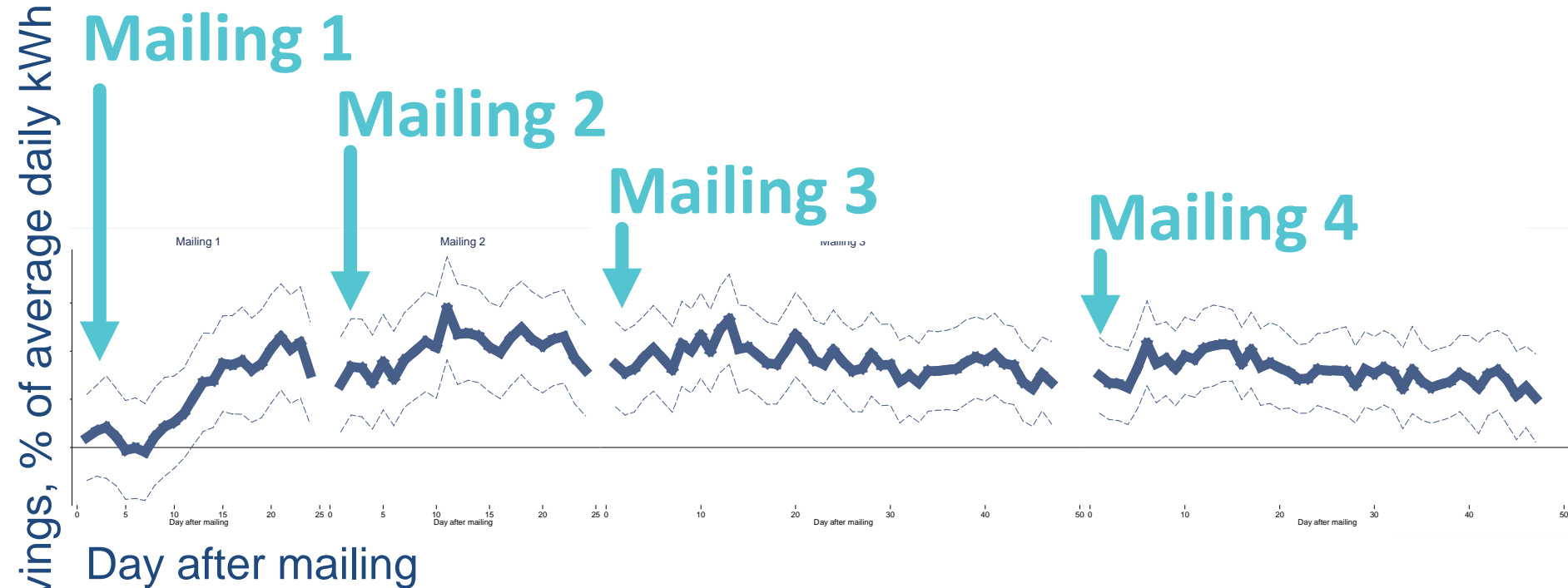
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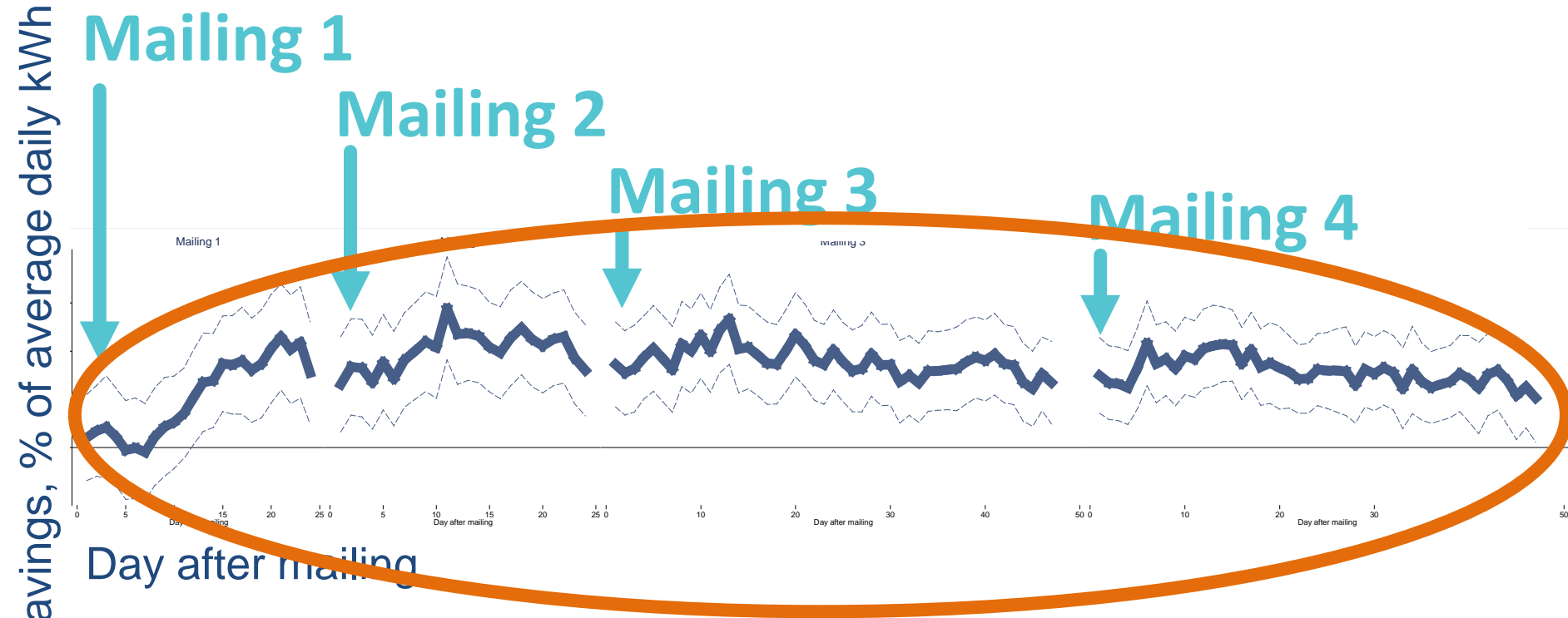


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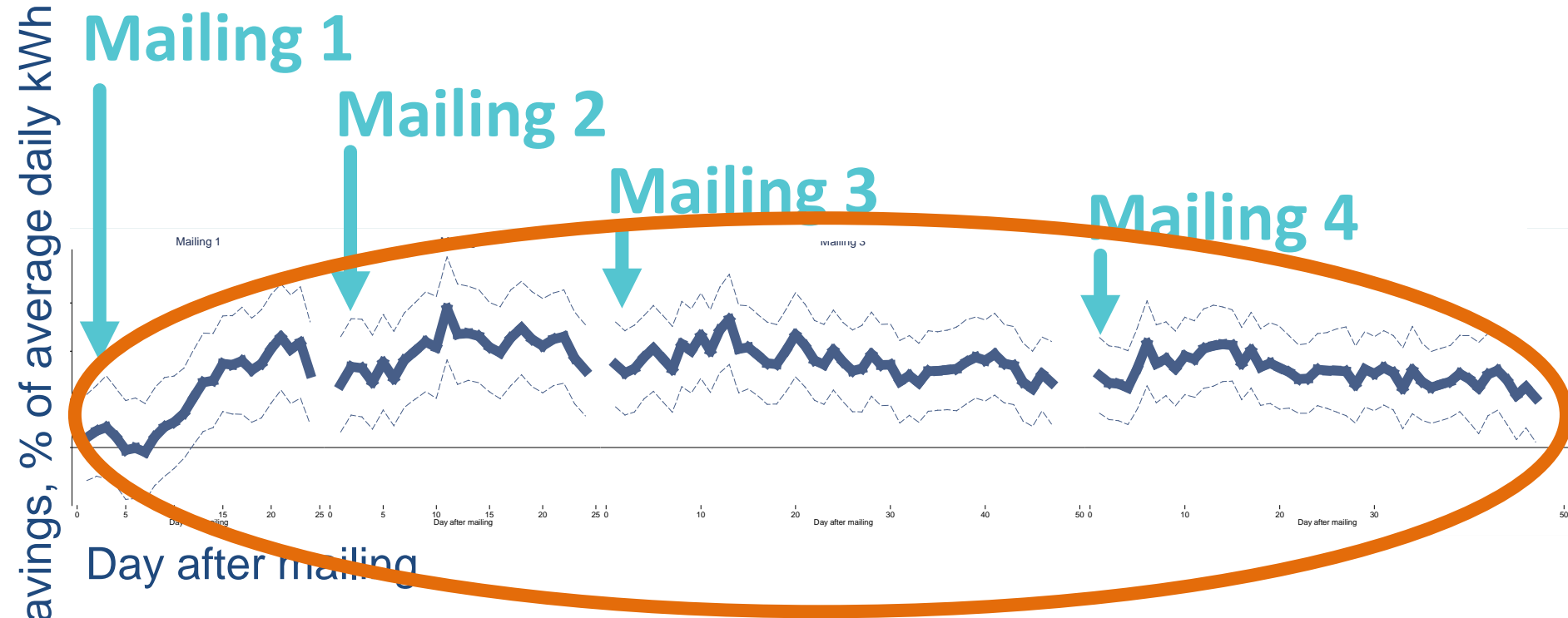
# Timing of when savings occur after HERs delivered now possible with Smart Meter



**Savings continue between mailings (there are statistically significant savings every day)**



# Timing of when savings occur after HERs delivered now possible with Smart Meter



However the level of savings appears to vary somewhat

# Analysis using Smart Meter data can help address key policy questions



- **Knowing hour-by-hour savings allows for more accurate cost-effectiveness estimates**
- **Knowing actions that might be undertaken by HH receiving HERs when savings are most needed should contribute to more effective targeted program marketing**
- **Knowing how quickly savings are achieved after HERS delivered and the degree to which those savings are maintained between deliveries should contribute to more effective DSM portfolio planning and HER program design**



# Implications of analysis on climate change mitigation efforts

- **Quantified and verified savings from HER programs with Smart Meter Data could be used to more accurately adjust CO<sub>2</sub> emission rate when demonstrating compliance with a rate-based CO<sub>2</sub> emission limit**
- **To maximize impact on CO<sub>2</sub> emission rates, HER programs can be targeted to coincide geographically and temporally with locations and times of poorest air quality**



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