



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

Using Data to Identify Energy Behaviors, Actions, and Characteristics of Households

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Smart meter data enables new types of analysis

- These data have the potential to provide tremendous value to a wide range of energy policies, for example
 - providing a better understanding of heterogeneous responses to programs,
 - which can inform program design,
 - and inform new methods for targeting recruitment efforts



Targeting

- Who do you want to spend resources on to recruit into a time-differentiated pricing, DR, or behavior-based program?
 - Those most likely to sign up
 - And most likely to respond to the program and provide the savings you want to achieve
 - These are often not the same people, but some overlap can exist
 - How do you find these people?



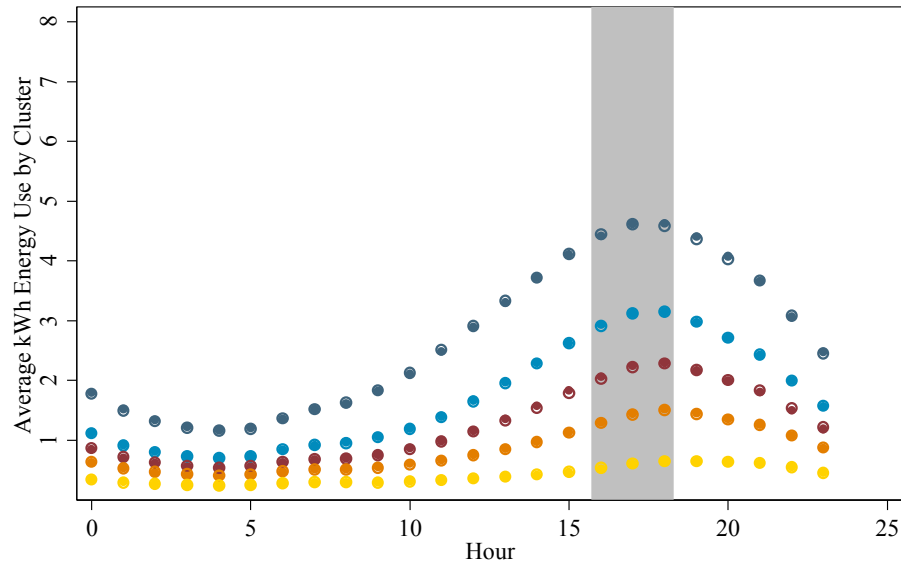
Setting the scene

- Our setting: CPP with IHD opt-in pricing pilot
- Classification approaches
 - Option 1: classify households based on percentile of average energy consumption (CL-P)
 - Option 2: classify households using clustering algorithms based on
 - Hourly energy use (CL-AV)
 - Standard deviation of hourly energy use (CL-SD)



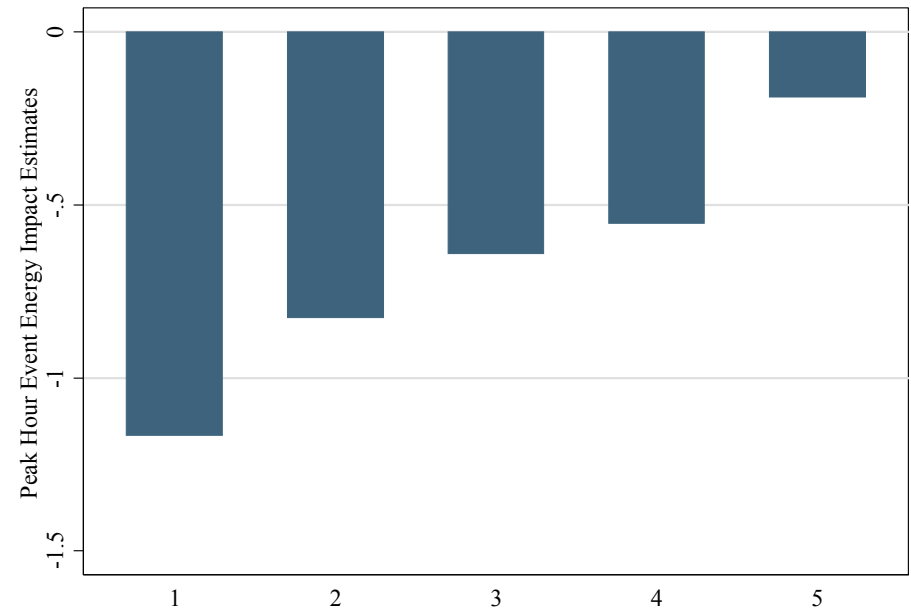
Option 1: CL-P

Percentile Groups of Hourly Energy Use
Pre-Treatment

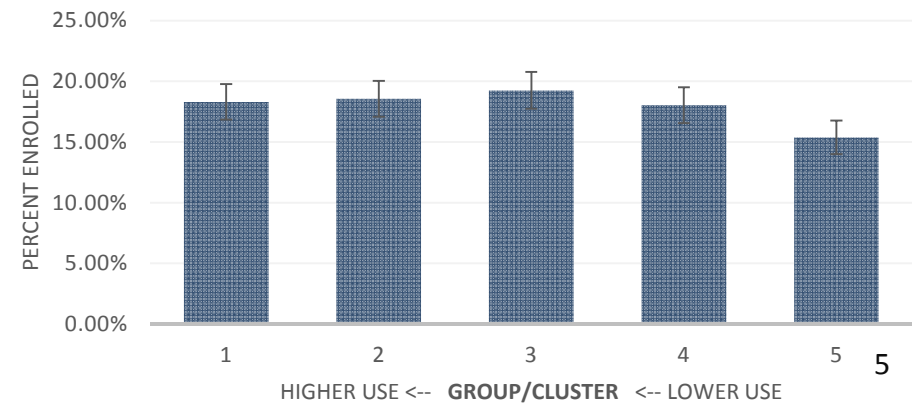


	Count
1	1,895
2	1,848
3	1,812
4	1,813
5	1,820

Estimate: CL-P



Overall Energy Use
Percentile Groups

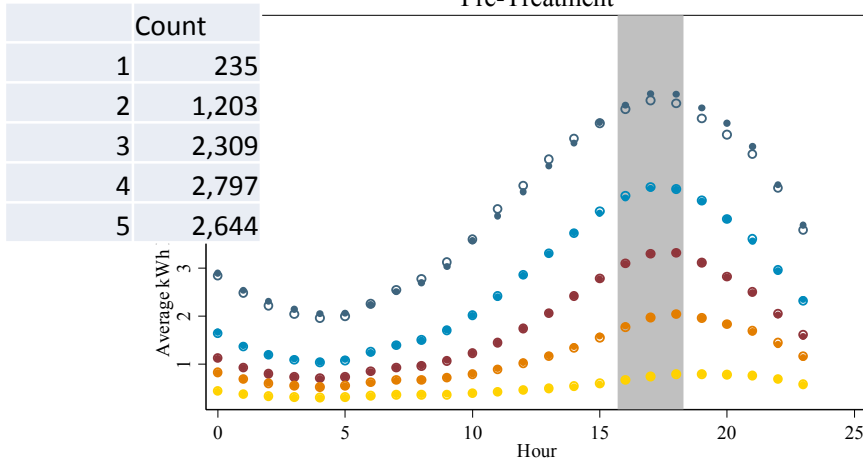


HIGHER USE <-- GROUP/CLUSTER <-- LOWER USE

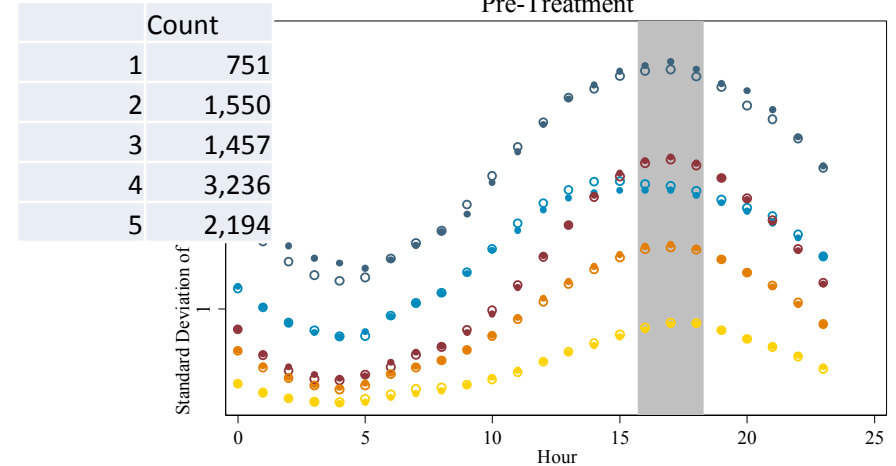


Option 2: K-means clustering approach

Cluster Based on Average Hourly Energy Use
Pre-Treatment



Cluster Based on Standard Deviation of Hourly Energy Use
Pre-Treatment

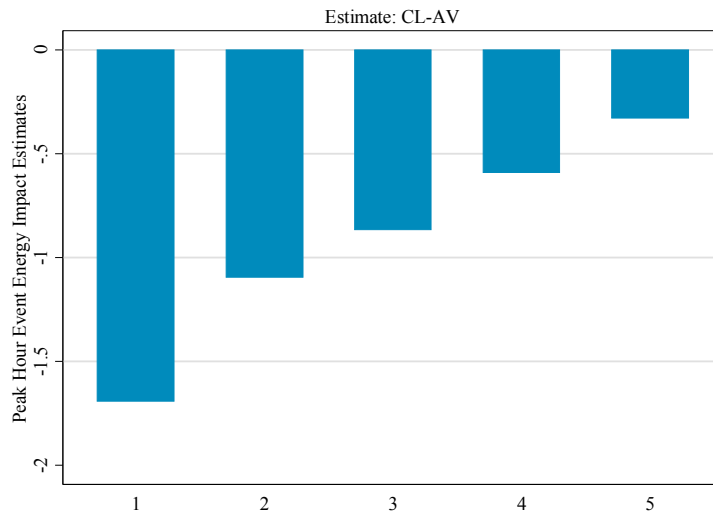


Clusters Based on Standard Deviation of Hourly Energy Use

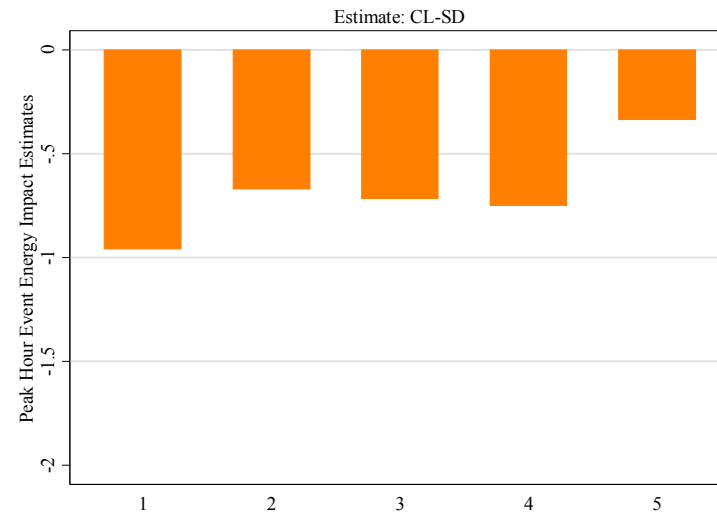
	Highest Use	1	2	3	4	5	Lowest Use
Clusters Based on Average Hourly Energy Use	1	310	196	24	18	3	3
2	860	1237	452	368	20		
3	538	1440	1577	1,906	164		
4	86	888	1395	3,740	934		
5	0	89	101	2054	4,336		
	Lowest Use						



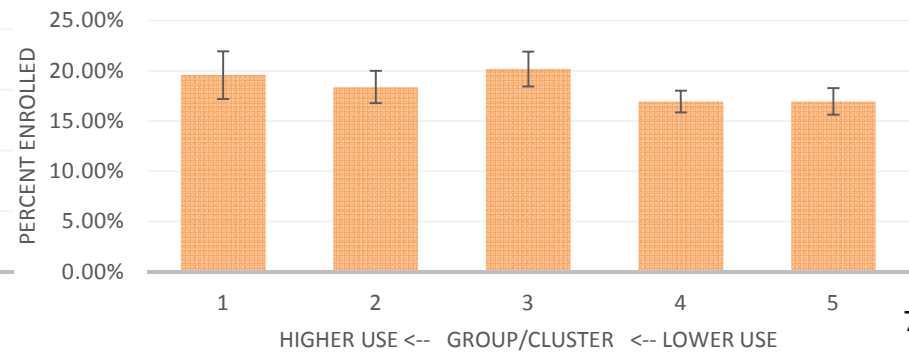
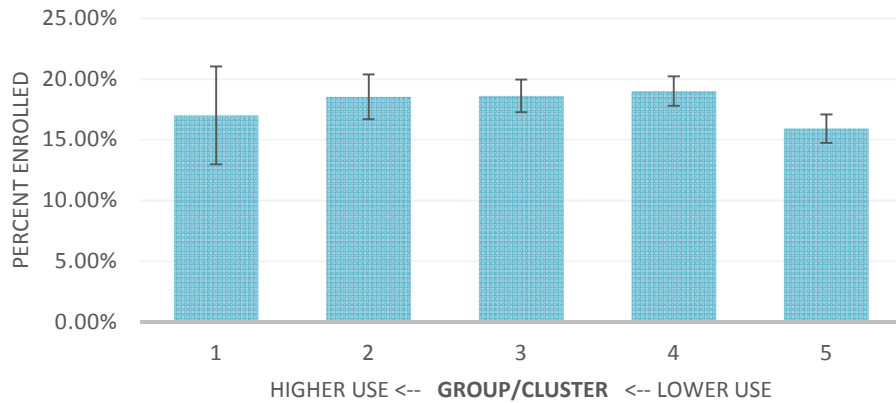
K-means clustering approach



Clusters Based on Average Hourly Energy Use



Clusters Based on Standard Deviation of Hourly Energy Use





Identify target group by combining these two sets of clusters

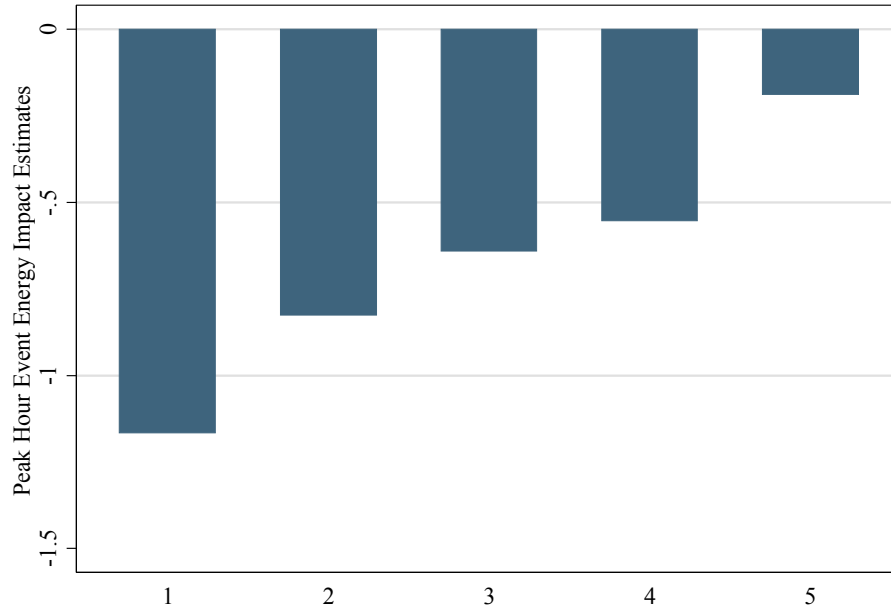
- New groups that make up CL-COMBO:

High Usage & High SD	{	1. CL-AV 1
		2. CL-AV 2
Mid-Low Use & High SD	{	3. CL-AV 3,4,5 & CL-SD 1
Mid-Low Use & Mid SD	{	4. CL-AV 3,4,5 & CL-SD 2,3,4
Mid Use & Low SD	{	5. CL-AV 3,4 & CL-SD 5
Low Use & Low SD	{	6. CL-AV 5 & CL-SD 5

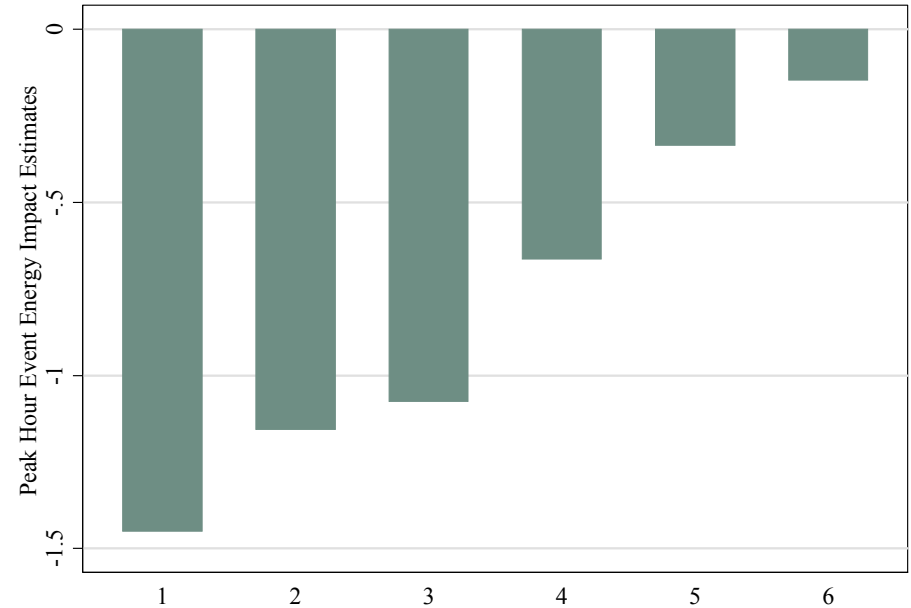


Comparison of Targeting Method

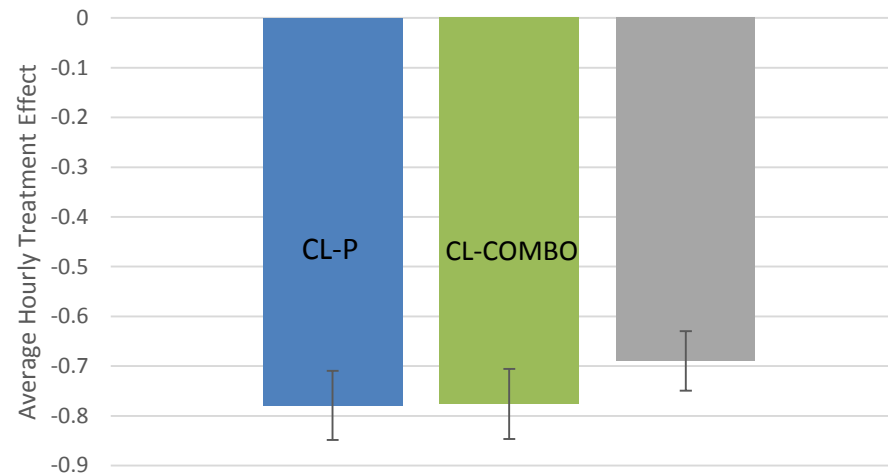
Estimate: CL-P



Estimate: CL-COMBO



Average Peak Period Treatment Effect



Number omitted from recruitment: 1820

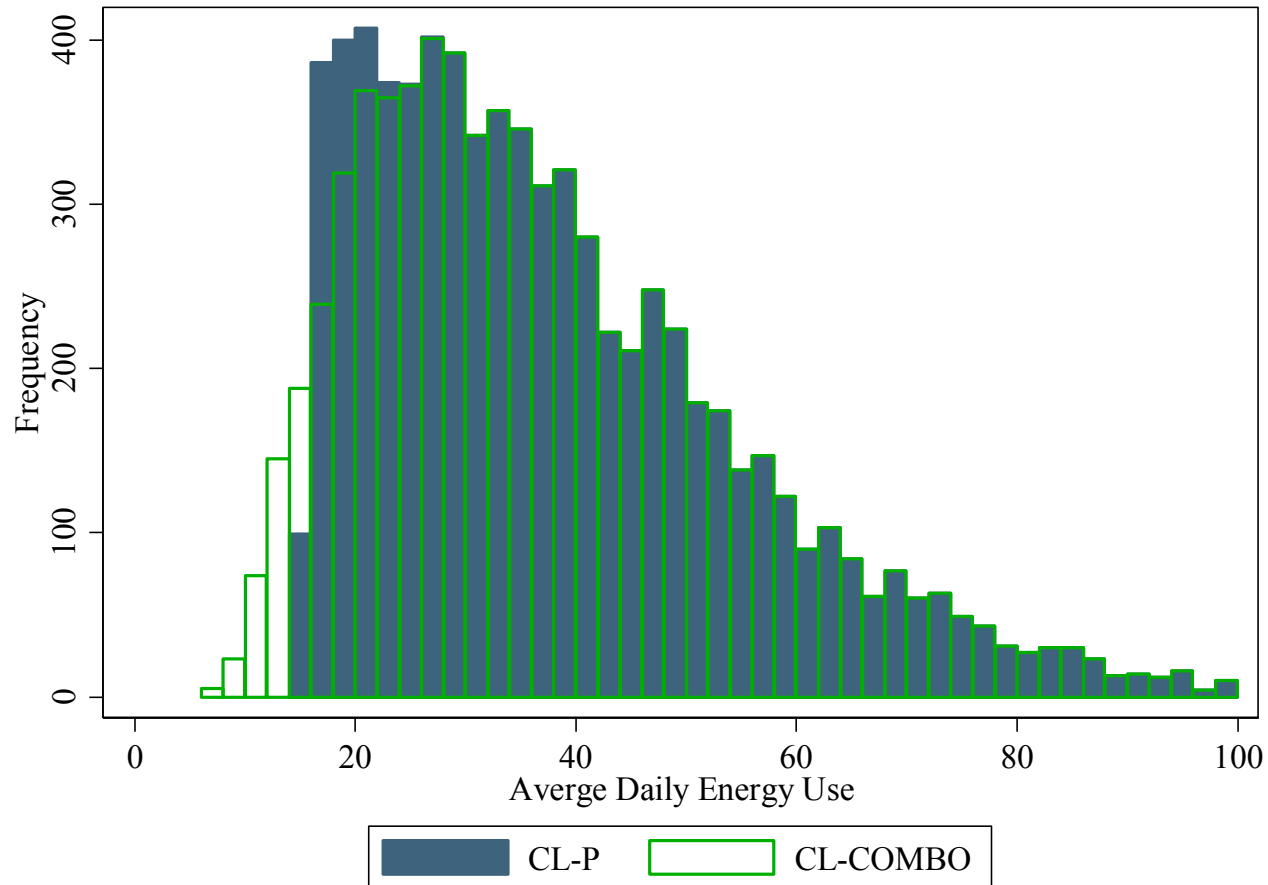
Opt-in rate: 18.5%
(vs 17.9%)

Number omitted from recruitment: 1761

Opt-in rate: 18.2%
(vs 17.9%)



Comparison of Targeting Method





In sum

- We defined a target group based on two methods
- We achieved higher average treatment effect with both, and higher opt-in rates with both
- However, the k-means clustering method, allowed low energy users with energy use variability to remain in the recruitment pool, rather than dropping all low users completely



Future work

- We are undertaking an ambitious research agenda which will
 - Identify more refined households characteristics using smart meter data (e.g., households with AC, thermostat set-points, etc.)
 - Ground-truth algorithms against survey data
 - Identify patterns of change in energy use in response to pricing programs to identify evidence of *how* households responded to the programs
 - Identify opportunities for unmet savings potential by targeting programs based on these classification methods



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