Carnegie Mellon University

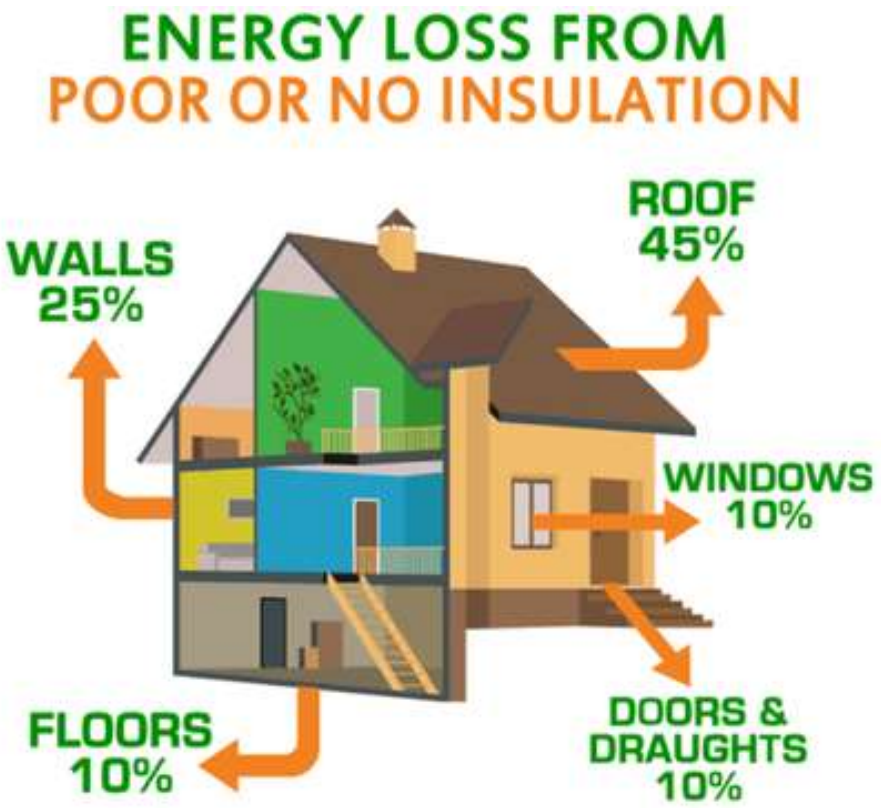
Utilizing household meter data to better identify and serve at-risk customers

Destenie Nock, PhD

Peoples Energy Analytics
Carnegie Mellon University
dnock@andrew.cmu.edu
Twitter: @DestenieNock

Who has ever lived in a house with…

An inefficient AC and no insulation?



Who has ever lived in a house with…

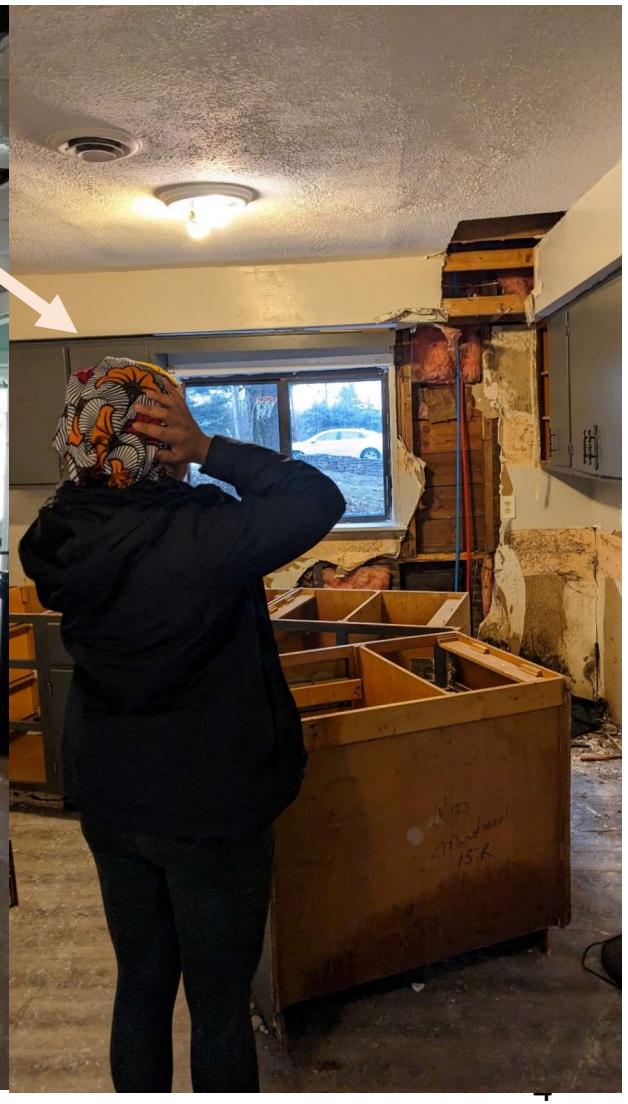
A broken Air Conditioner?

How Many People In the Audience Have Experienced Pipes Freezing in your Home because you(or someone you know what trying to save money on the heating bills)?

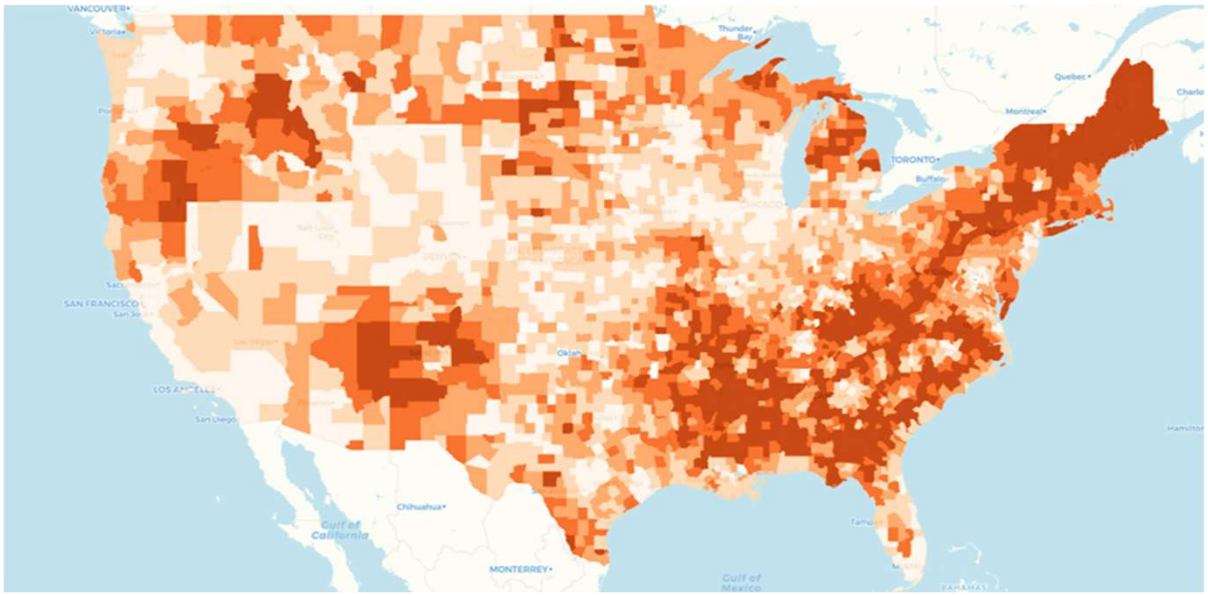
2022 Christmas cold snap in led to the entire duplex losing access to water

That's me ☹

(My tenet trying to save money on bills led to big consequences…worst day as a landlord)

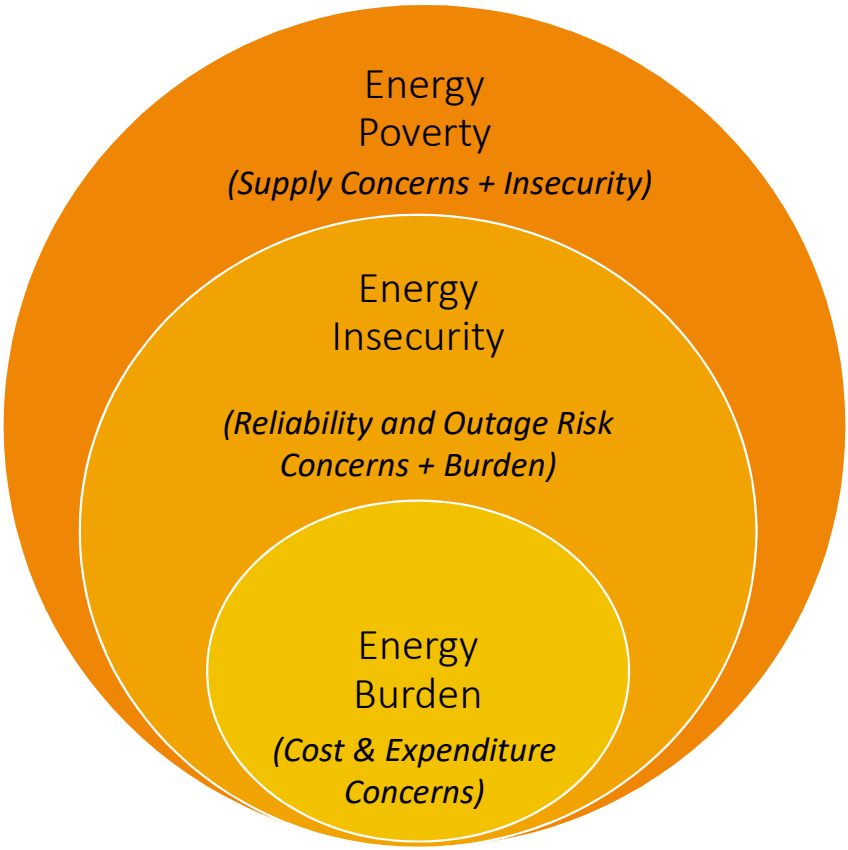


Energy poverty discussions dominated by Energy Burden

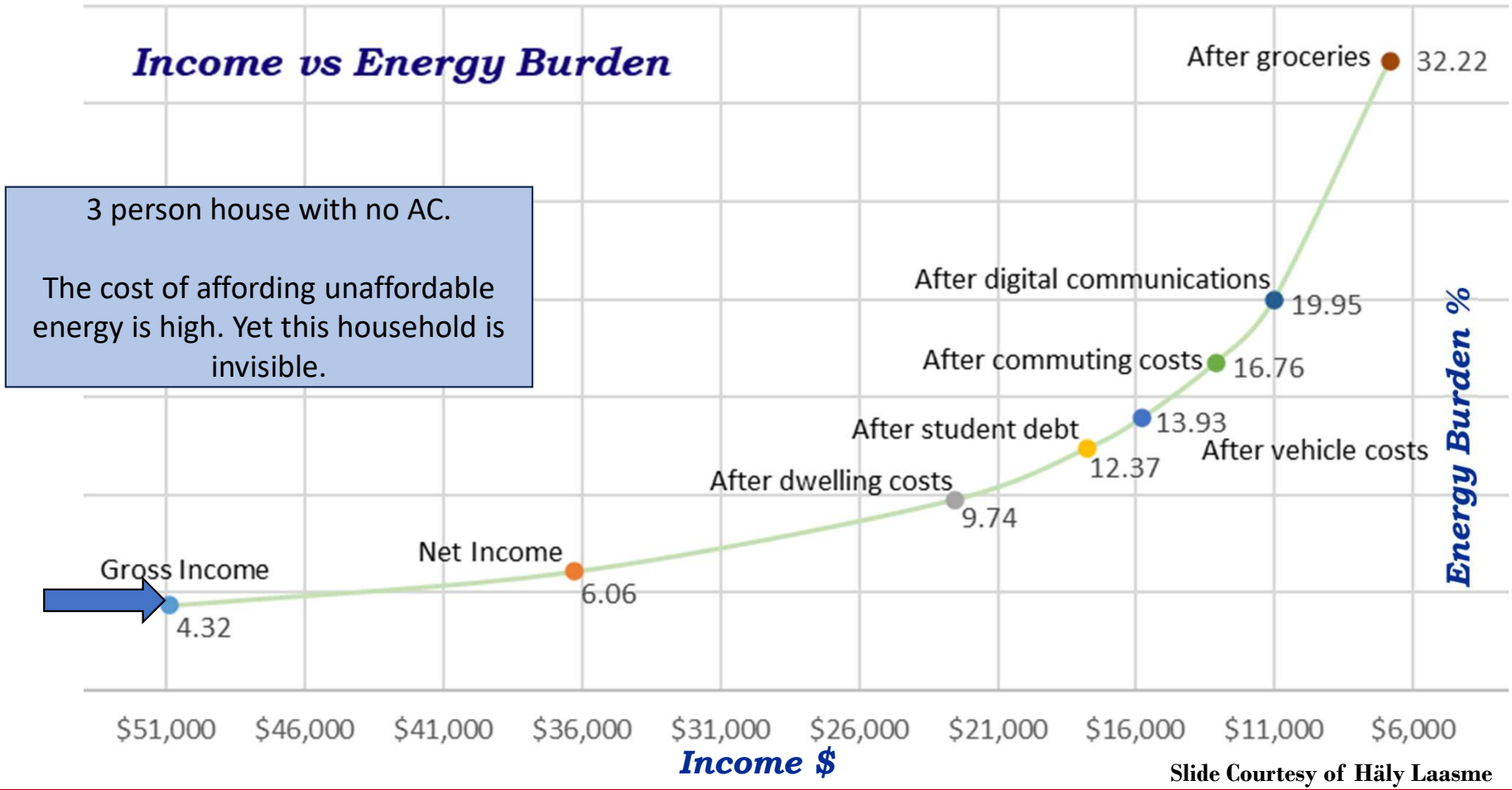


Energy burdens (at the county level) for LMI (low and moderate-income) households. The lightest color in the choropleth scale is <6% of annual income spent on housing energy bills, and the darkest is >19%.

https://blog.ucsusa.org/joseph-daniel/how-to-make-energy-burden-less-bad



Gross Income misses the big picture and true fraction



Slide Courtesy of Häly Laasme

Disconnections are costly

(Early identification is critical)

Years of abnormal, low energy use

Customer late on payments or defaults on bills

Notification to customer

Customer default

Disconnection

Household Meters Widely Underutilized

- In 2021, U.S. electric utilities had about 111 million advanced (smart) metering infrastructure (AMI) installations, equal to about 69% of total electric meters installations.
- Residential customers accounted for about 88% of total AMI installations, and about 69% of total residential electric meters were AMI meters.

Using Data to Unveil Hidden Energy Poverty

Lessons from Arizona, Illinois, and the Mid-Atlantic

Cong, S., Nock, D., Qiu, Y. L., & Xing, B. (2022). Unveiling hidden energy poverty using the energy equity gap. *Nature communications*, *13*(1), 2456.

Huang, L., Nock, D., Cong, S., & Qiu, Y. L. (2023). Inequalities across cooling and heating in households: Energy equity gaps. *Energy Policy*, *182*, 113748.

Energy Limiting Behavior: A Hidden Inequity

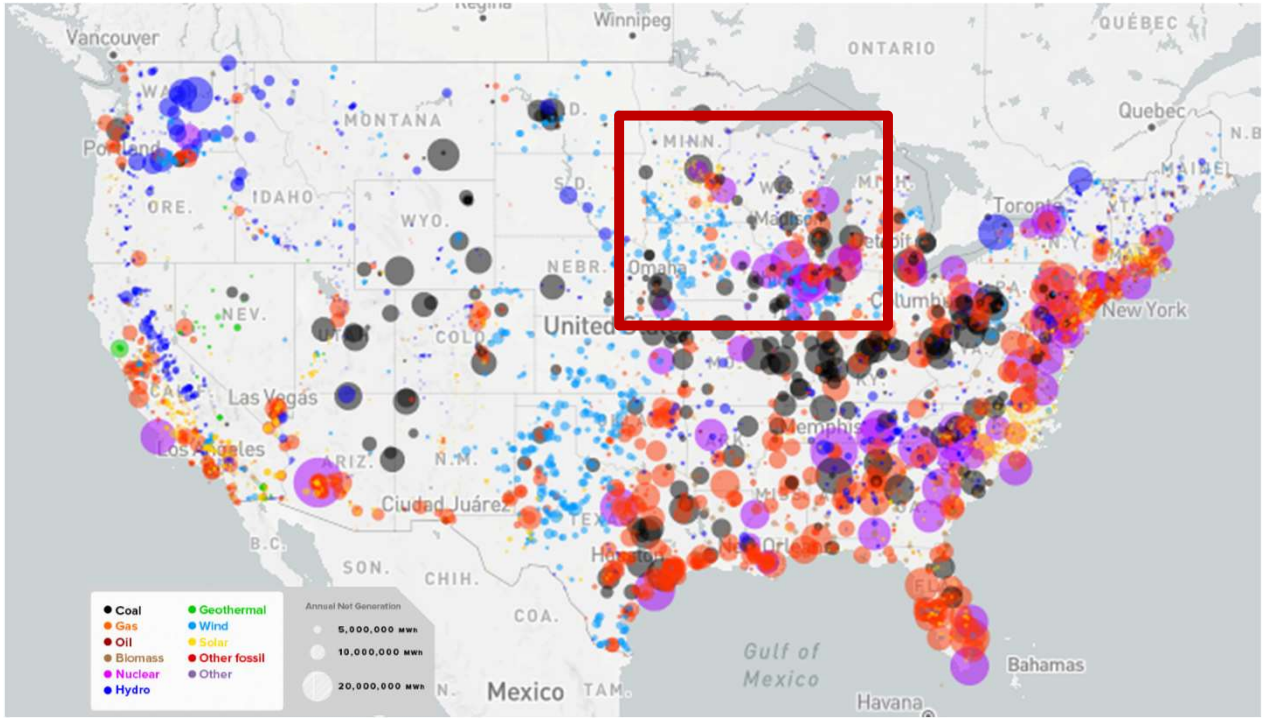
Able to satisfy all your demand but high cost.

People able to satisfy partial needs, but may be at risk

Unable to satisfy any of your demand (outage, disconnected)

Need to integrate human behavior and people's tendency to reduce their energy consumption to save money, and potential long term energy limiting behavior into energy models.

Study area: Illinois

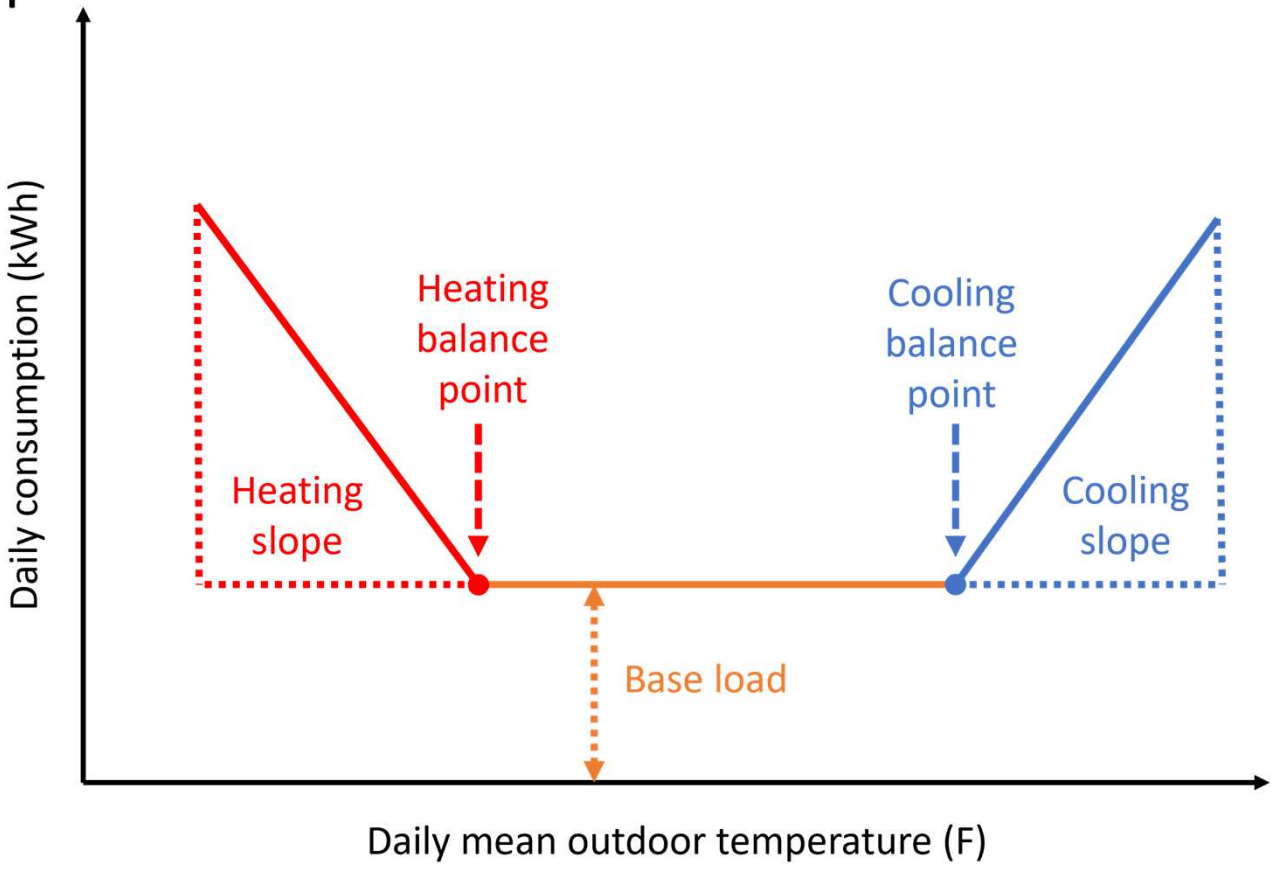


US Power Plants, 2019
https://physics.weber.edu/schroeder/energy/PowerPlantsMap.html

Climate Illinois: Cold and harsh winter, mild summer

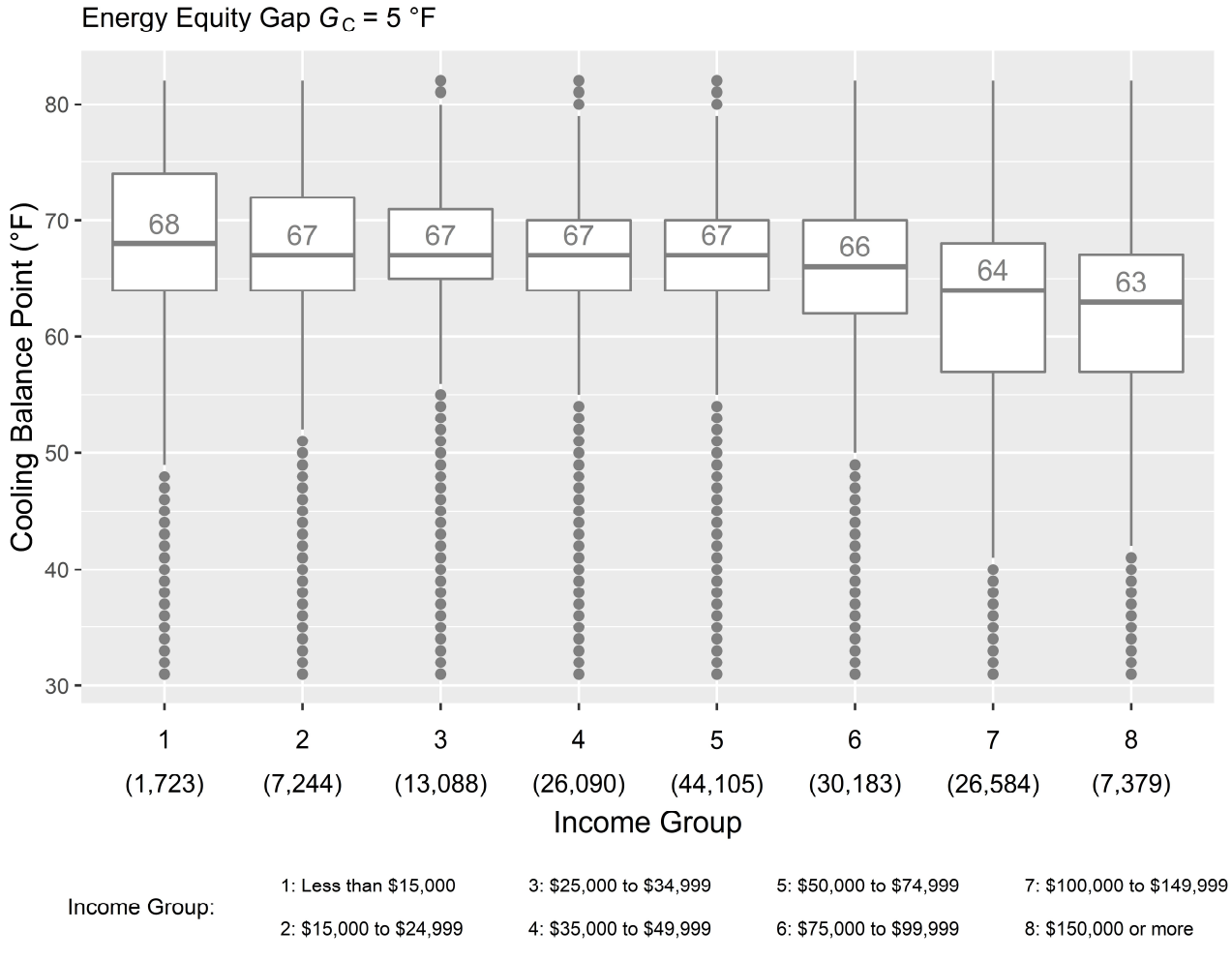
Analysis of over 150,000 households in ComEd region

Five Point Regression to Identify Electricity Consumption Behavior for individual households



Chicago: the energy equity gap (EEG) for cooling

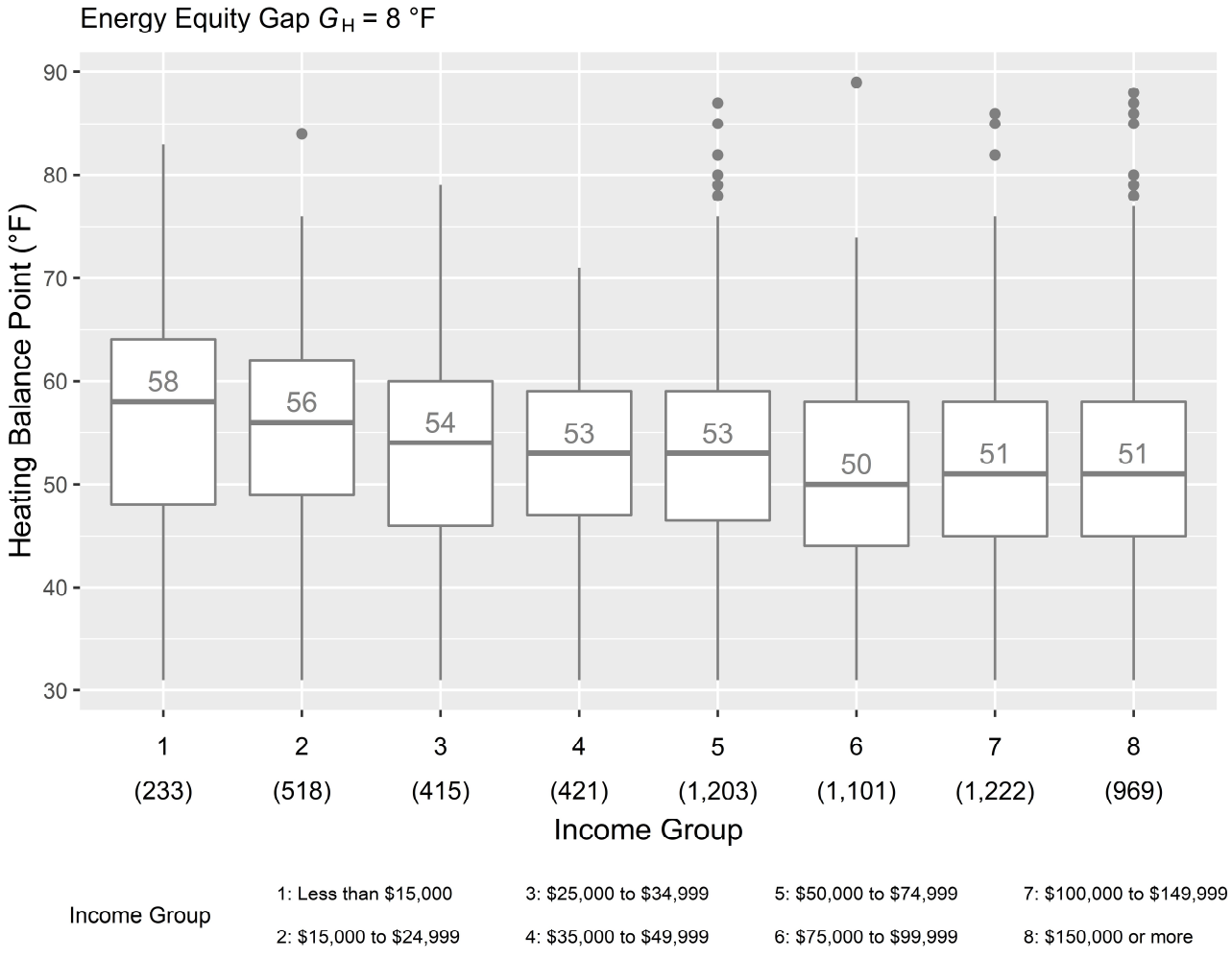
- Smart meter data for over 150,000 households
- $EEG = \max(\text{inf}\_temp_{median}) - \min(\text{inf}\_temp_{median})$



Huang et al 2023

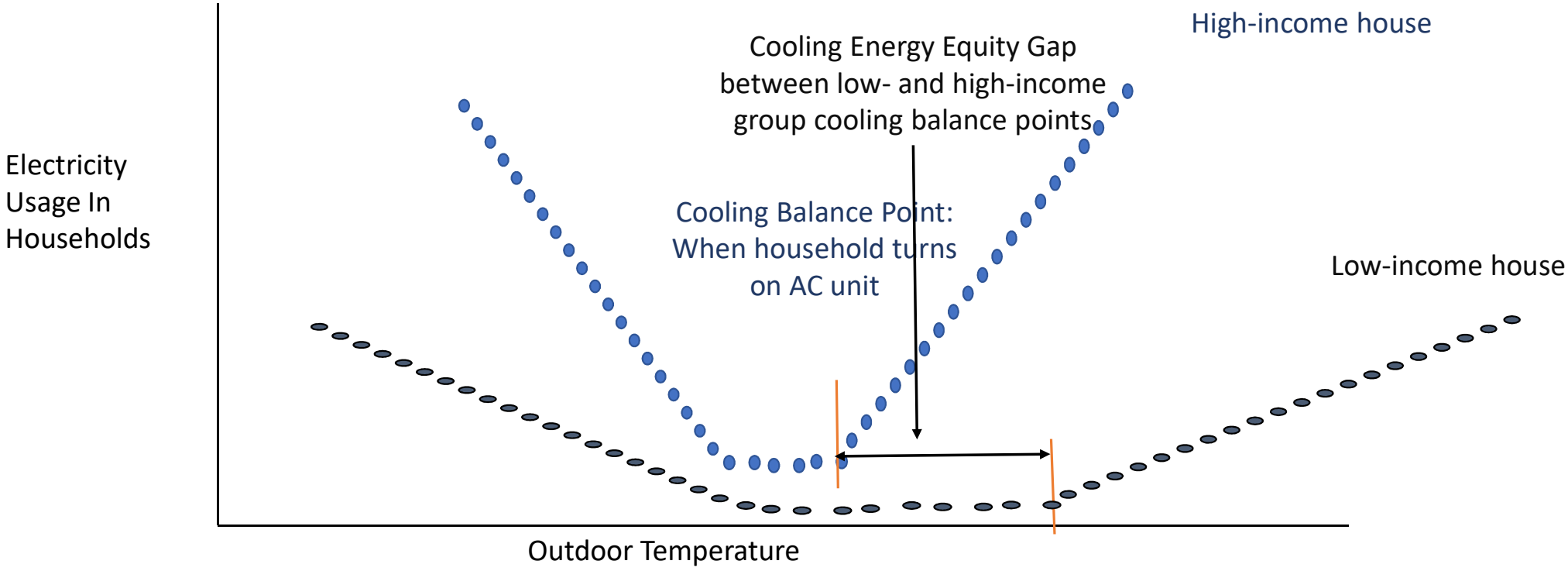
Chicago: In heating the low income groups start using earlier.

- Smart meter data for ~6,000 households
- Low income groups start using heating earlier in the winter in Chicago
- Lack of insulation, despite other studies reporting households set to the same indoor temperature.



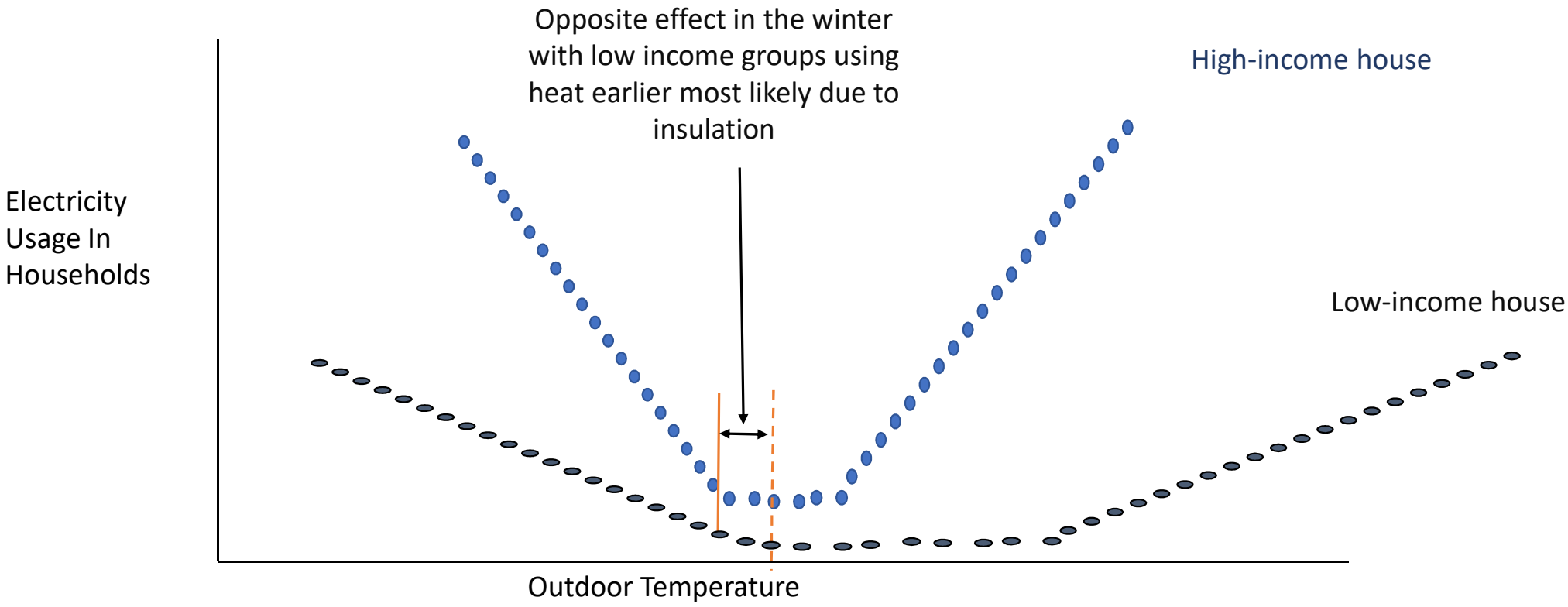
Huang et al 2023

Energy Equity Gap – Using Smart meter (AMI) data



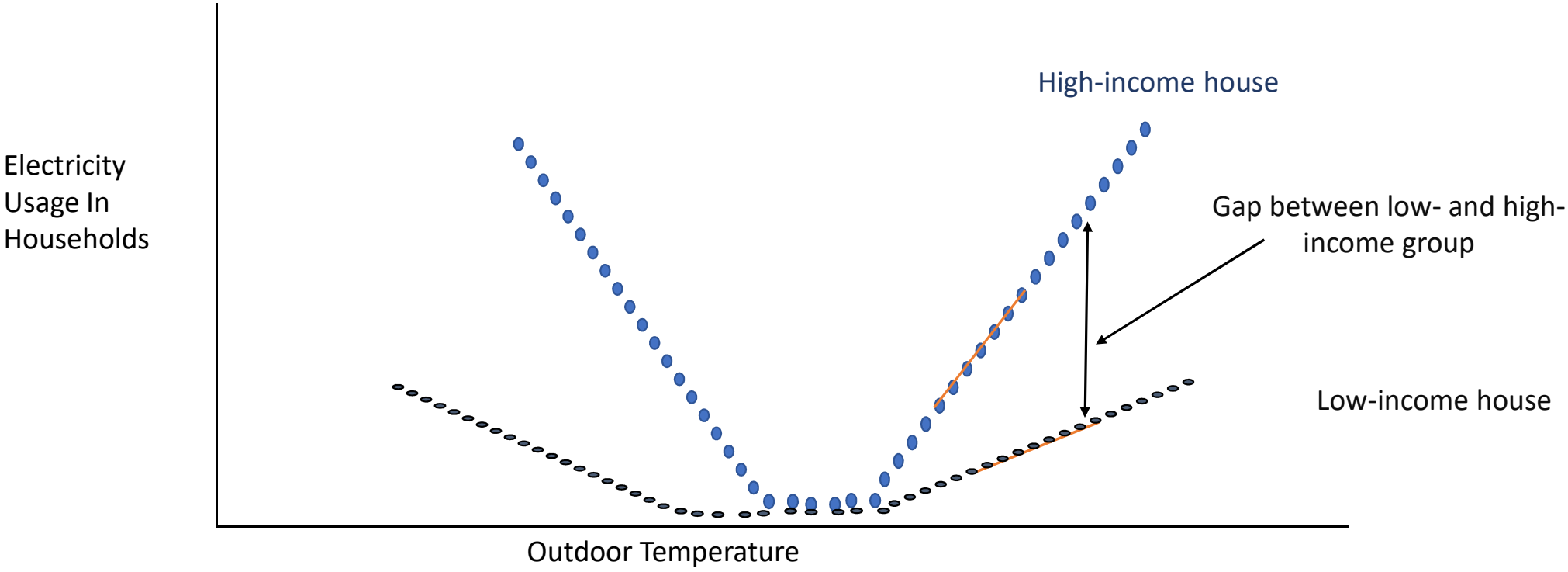
(Cong et al 2022 in Nature Communications and Huang et al (under revision))

Energy Equity Gap



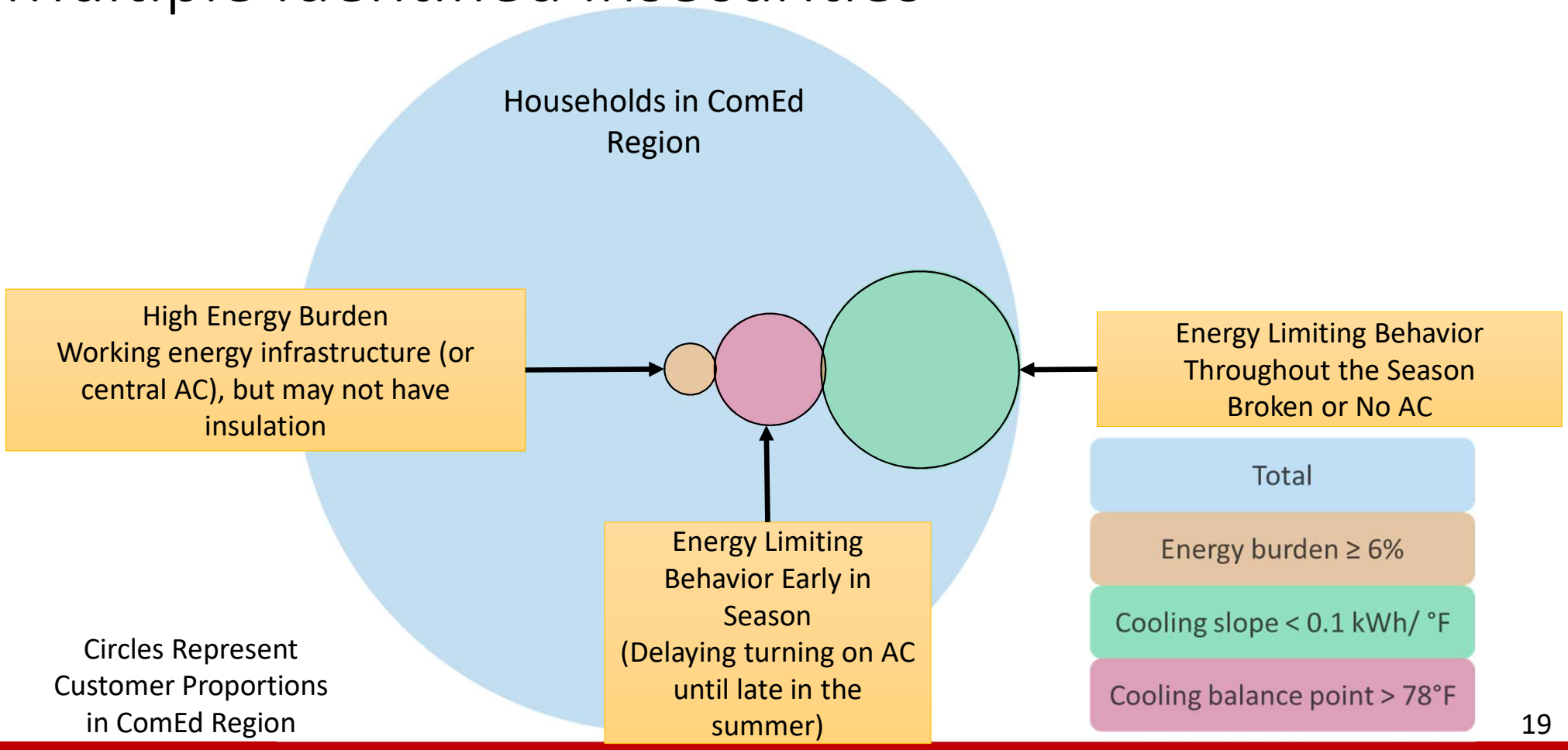
(Cong et al 2022 in Nature Communications and Huang et al (under revision))

Slope Gap



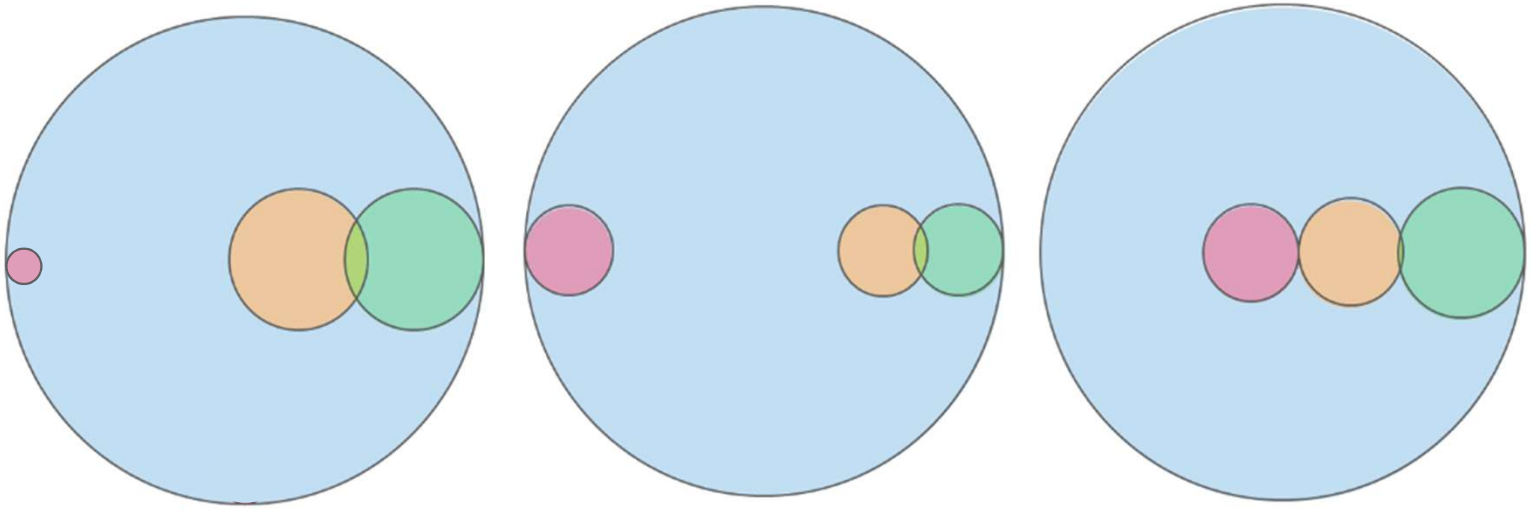
(Kwon et al (submitted to journal))

Multiple Identified Insecurities



Circles Represent Customer Proportions in ComEd Region

Comparing the Incidence of energy poverty differs across study regions



SRP
2018

ComEd
2020-2021

Utility X
2018

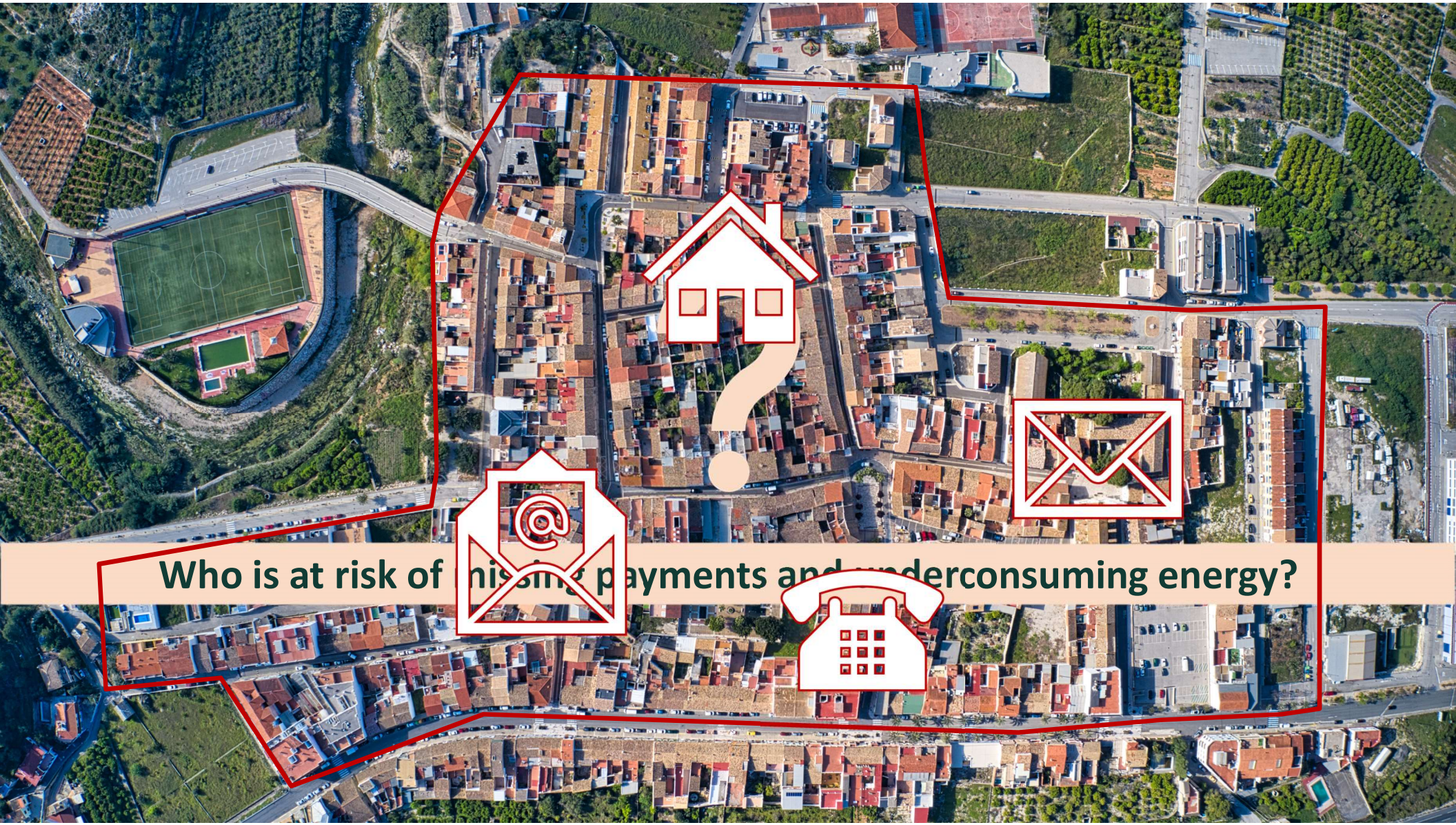
Total

Energy burden ≥ 6%

Cooling balance point > 78°F

Cooling slope < 0.1

Models need multiple consumer profiles with varying behavior

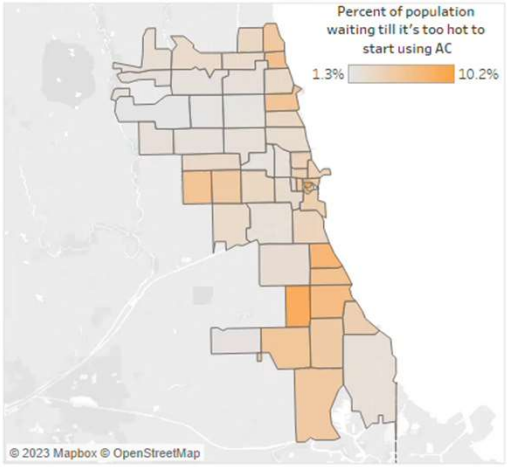

Who is at risk of missing payments and underconsuming energy?


Identify abnormal consumption in households

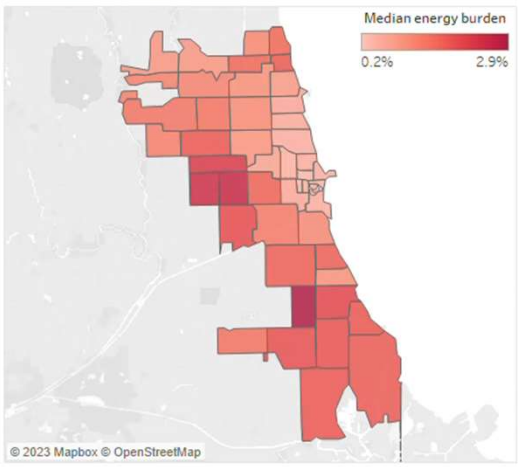
Beyond identification

Peoples Energy Analytics

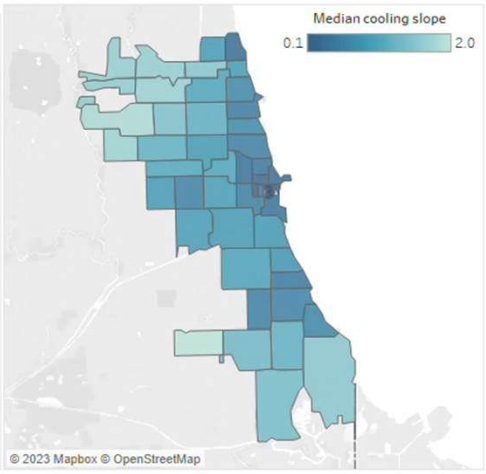
Zip codes to target to reduce heat risk



Energy burden



High risk regions lacking air conditioners



Accounts waiting till it's too hot to start using AC

Accounts	
100181283	82
100181326	82
100181333	82
100181333	82
100181386	82
100181421	82
100181421	82
100181466	82
100181542	82
100181614	82
100181617	82
100181633	82
100181648	82
100181832	82
100181867	82
100181918	82

Accounts with high energy burden

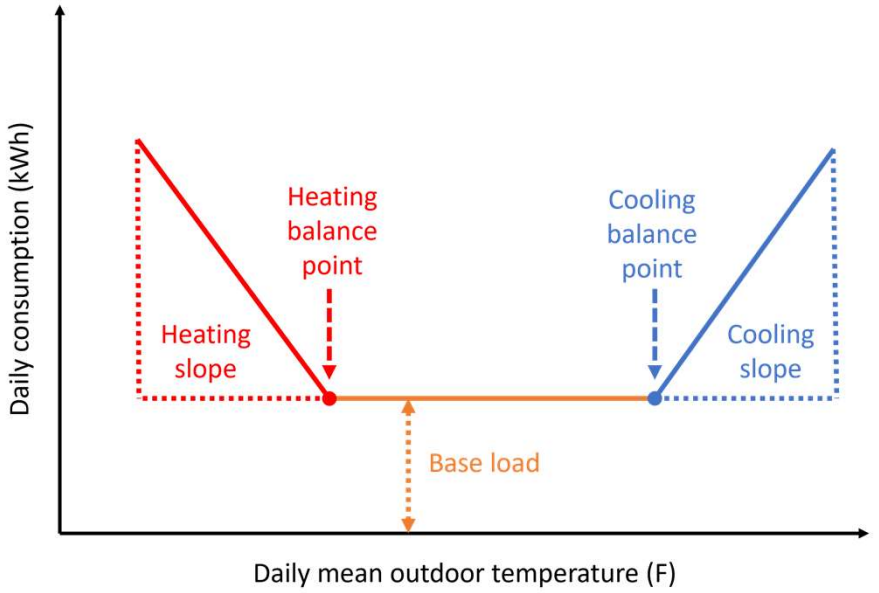
Accounts	
1001907	16.9%
1001859	16.5%
1001897	14.6%
1001853	14.2%
1001906	14.2%
1001842	14.0%
1001893	13.7%
1001836	13.7%
1001843	13.6%
1001822	13.4%
1001866	13.3%
1001838	12.9%
1001824	12.4%
1001889	12.4%
1001817	12.4%
1001905	12.2%
1001857	12.1%
1001866	12.0%

Low income households to target with cooling upgrades

Accounts	
10018301	0.000
10018986	0.000
10018481	0.000
10019033	0.000
10018445	0.001
10018251	0.001
10018555	0.001
10018982	0.001
10018547	0.001
10019008	0.002
10019080	0.002
10018276	0.003
10018143	0.003
10018274	0.003
10018803	0.003
10018734	0.003

These metrics can…

- Allow for better targeting of energy efficiency upgrades and identification of at-risk households before they default on their energy bills (work we are doing at Peoples Energy Analytics)
- Make better use of widely available but underutilized smart meter data.
- We identify customers at a **94% cost reduction** compared to traditional methods.



Peoples Energy Analytics

Some Metrics You Can Extract From Meter Data

- At Risk through Energy Deficits
  - Number of customers without Air Conditioners
  - Number of customers with broken ACs
  - Number of customers at risk of heat stroke
  - Number of customers at risk of having their pipes freeze
- At Strong Financial Risk
  - Percent of Income Spent on Bills
  - Risk of being Disconnected
- Over Consumers
  - Number of customers without Efficient Air Conditioners or Heating Systems

Peoples Energy Analytics

Conservation Laws that Have Unietended Consequences

- Example PA Act 129 states utilities cannot encourage households to use more energy.

- What about households with out ACs
- What about households that use too little energy during cold snaps?

Want to Work together?

- Peoples Energy Analytics
- Our Company which helps utilities analyze customer data to identify energy poverty and reduce unpaid energy bills.
- More effective targeting of vulnerable customers leads to greater program participation and less bad debt.
- Uses widely deployed but underutilized AMI (smart meter) data

Peoples Energy Analytics

www.PeoplesEnergyAnalytics.com

Contact and Acknowledgements

- Destenie Nock
  - E-mail: dnock@andrew.cmu.edu
  - Email: Destenie@peoplesenegryanalytics.com
  - Twitter: @DestenieNock

www.PeoplesEnergyAnalytics.com

- This work is funded in part by the National Science Foundation [grant numbers 2029511; 2017789], the Sloan Foundation, the Google Award for Innovation grant, and the Scott Institute for Energy Innovation at CMU.