

# Want to Reduce Energy Consumption? Don't Depend on the Consumers!

\* Haroon Rashid, + Priyanka M. Mammen, + Siddharth Singh,  
+ Krithi Ramamritham, \* Pushpendra Singh, \$ Prashant Shenoy

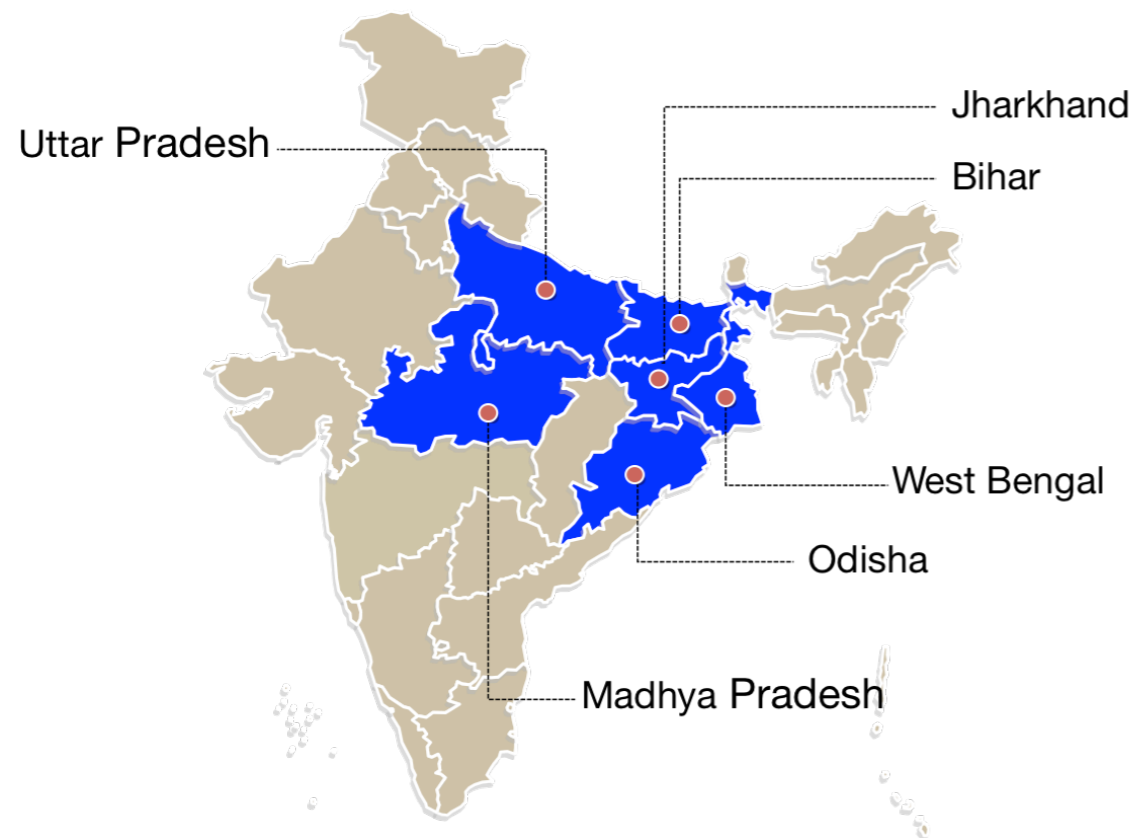
\* IIIT Delhi, + IIT Bombay, \$ UMass Amherst



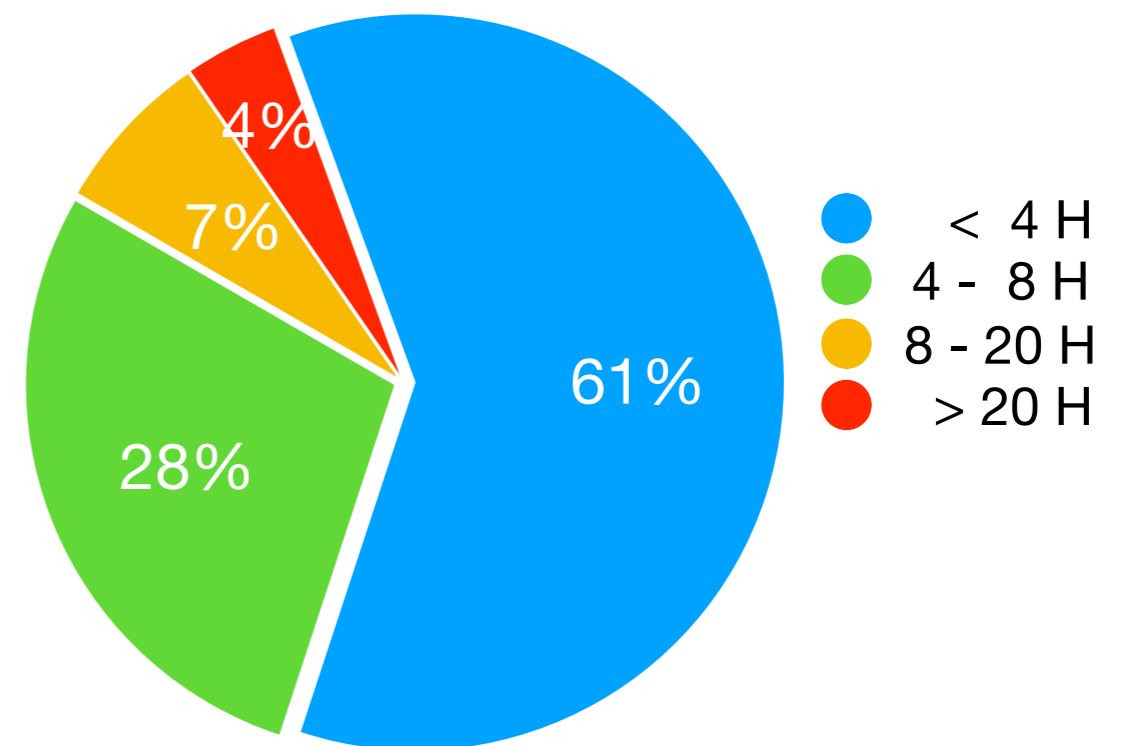
# Why to Reduce Energy Consumption?

- CEEW institute conducted a study across 6 Indian states in 2015\*
- 61% of households have less than 4 hours of electricity available per day

Highlighted Surveyed States



Households Distribution w.r.t. Power Availability



\* Access to clean cooking energy, and electricity: Survey of states, CEEW, September 2015

# How to Manage Energy Demand?

# How to Manage Energy Demand?

- Producer side solution
  - Increase power generating capacity

# How to Manage Energy Demand?

- Producer side solution
  - Increase power generating capacity
- Consumer side solution
  - Use energy-efficient appliances
  - Motivate consumers to reduce peak energy consumption

# How to Manage Energy Demand?

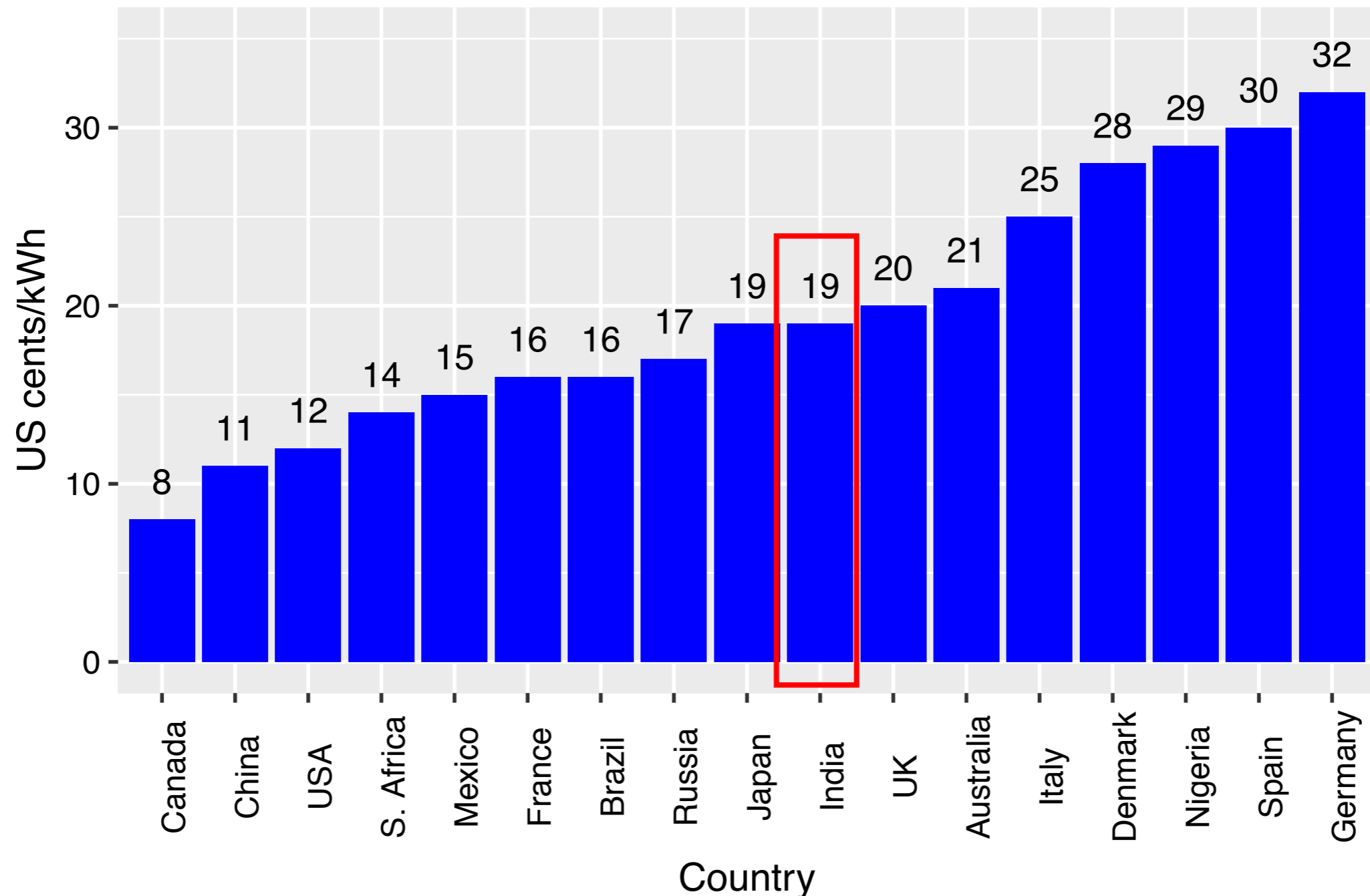
- Demand side solution
  - Increase power generating capacity

**Studies show it is difficult to change consumer's energy consumption behaviour<sup>1</sup>**

- Motivate consumers to reduce energy consumption

1. Designing persuasive technology to manage peak electricity demand in Ontario homes, ACM CHI, 2015

# Do Higher Electricity Prices Mean More Energy Conscious Consumers?



# Survey Building

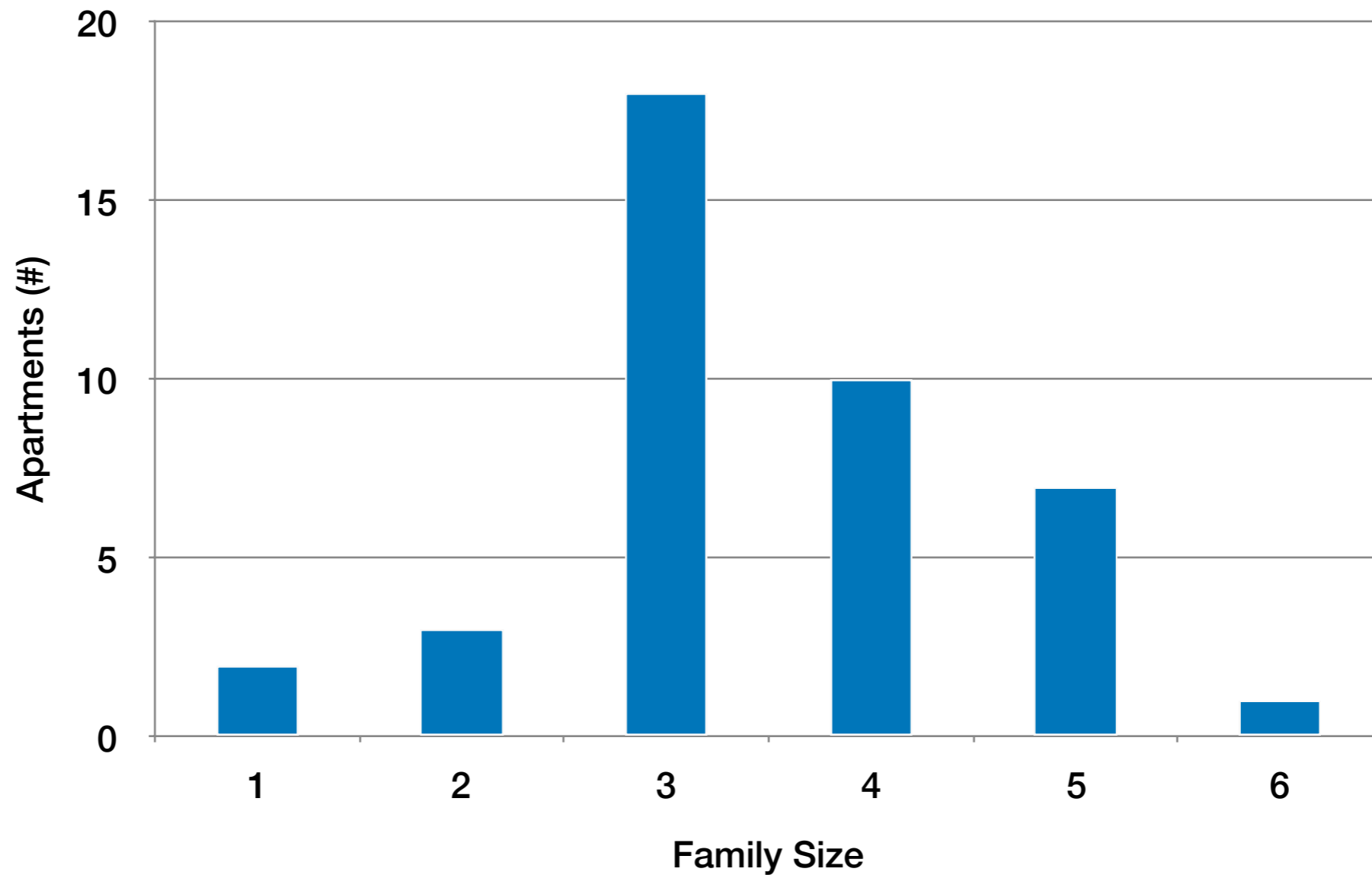
- Urban middle-class users
- 15 floors
- 60 apartments
- Separate smart meter





# Family Size Distribution

41 apartments participated in the survey



# Our Questionnaire

1. What is your average monthly electricity bill (in Rupee)?

< 500

501 - 1000

1001 - 1500

1501 - 2000

> 2000

2. At what time of the day you have a peak in energy consumption?

6 AM - 9 AM

9 AM - 12 PM

12 PM - 6 PM

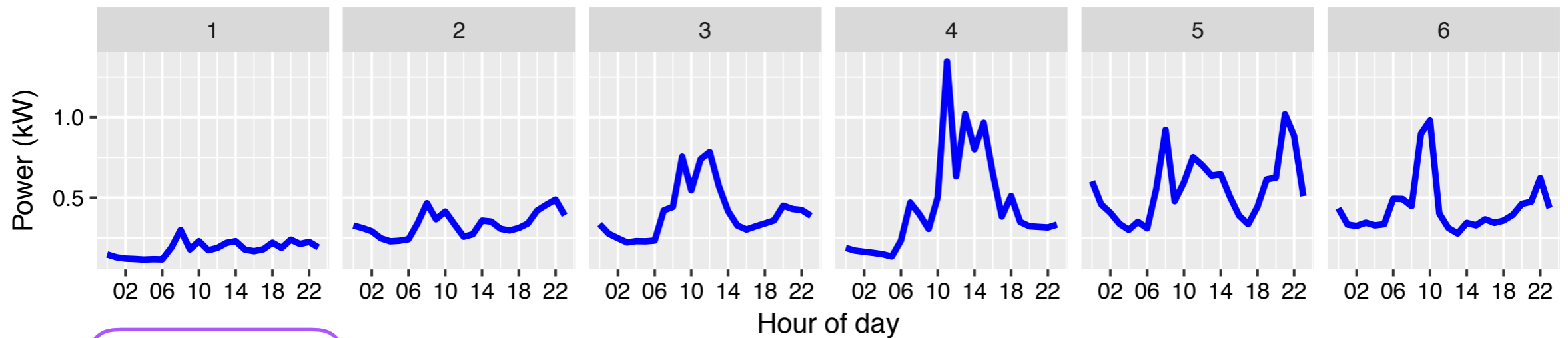
6 PM - 8 PM

8 PM - 6 AM

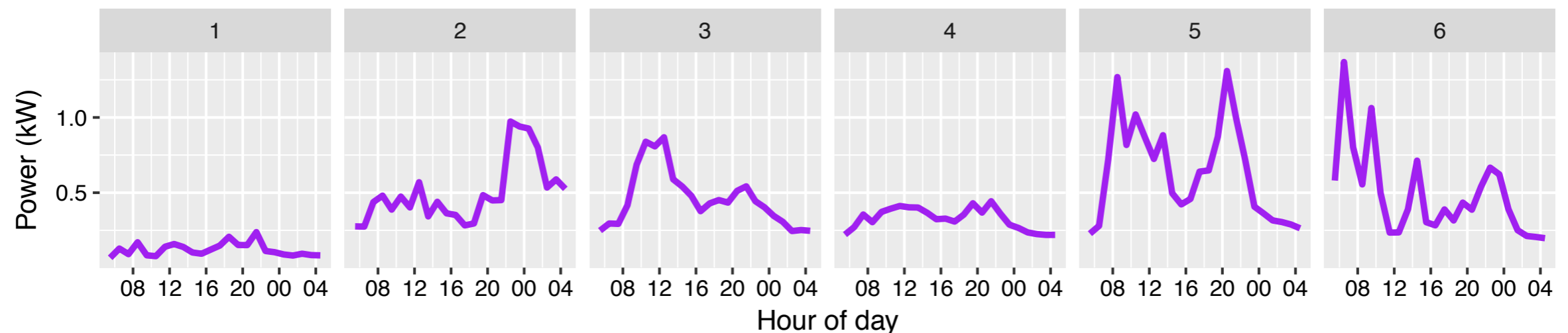
# Our Questionnaire

3. Which consumption profile do you think your usage lies on a typical weekday & weekend of September 2016?

Weekday



Weekend



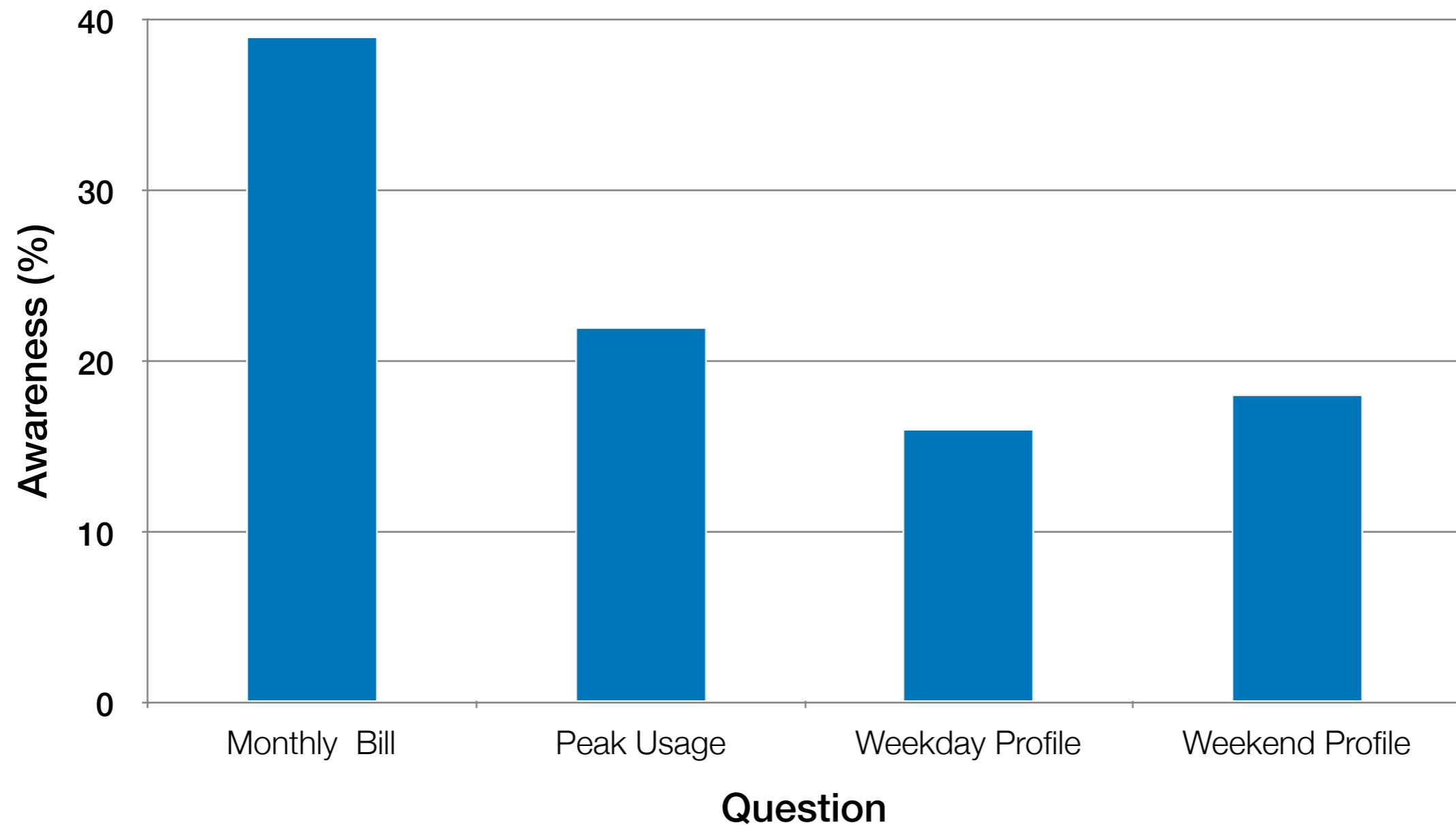
# Survey Execution

- Informed tenants one-week before
- Door-to-door paper based survey
  - Team: Three students and a Professor
  - Duration: Six hours
- Update responses in a CSV file

# How to Find the Accuracy of Recorded Responses?

- Six months smart meter data
- For each apartment, compute
  - Number of electricity units consumed
  - Peak usage time
  - Consumption profile

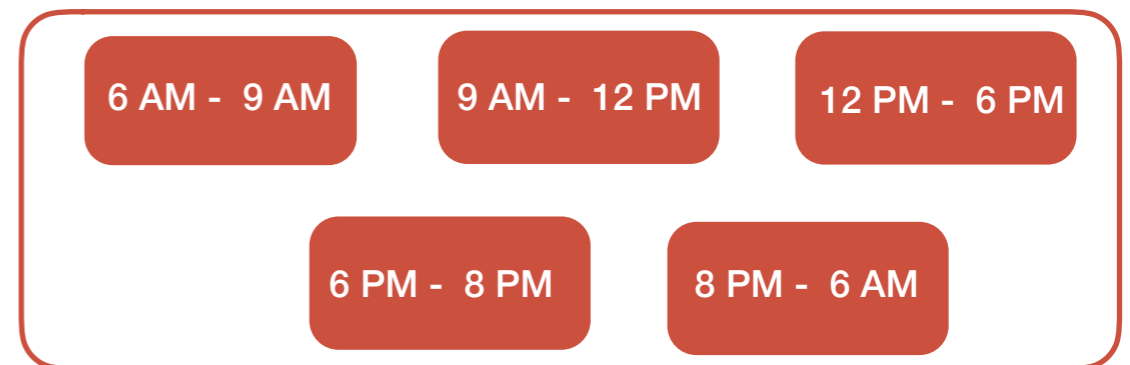
# What Percentage of Consumers were Energy Aware?



# Difference Between Reality & Consumer's Perception

# Difference Between Reality & Consumer's Perception

Peak awareness options:



Range error:

$$= \text{Actual range} - \text{Response range}$$

Actual range:

6 AM - 9 AM

Response range:

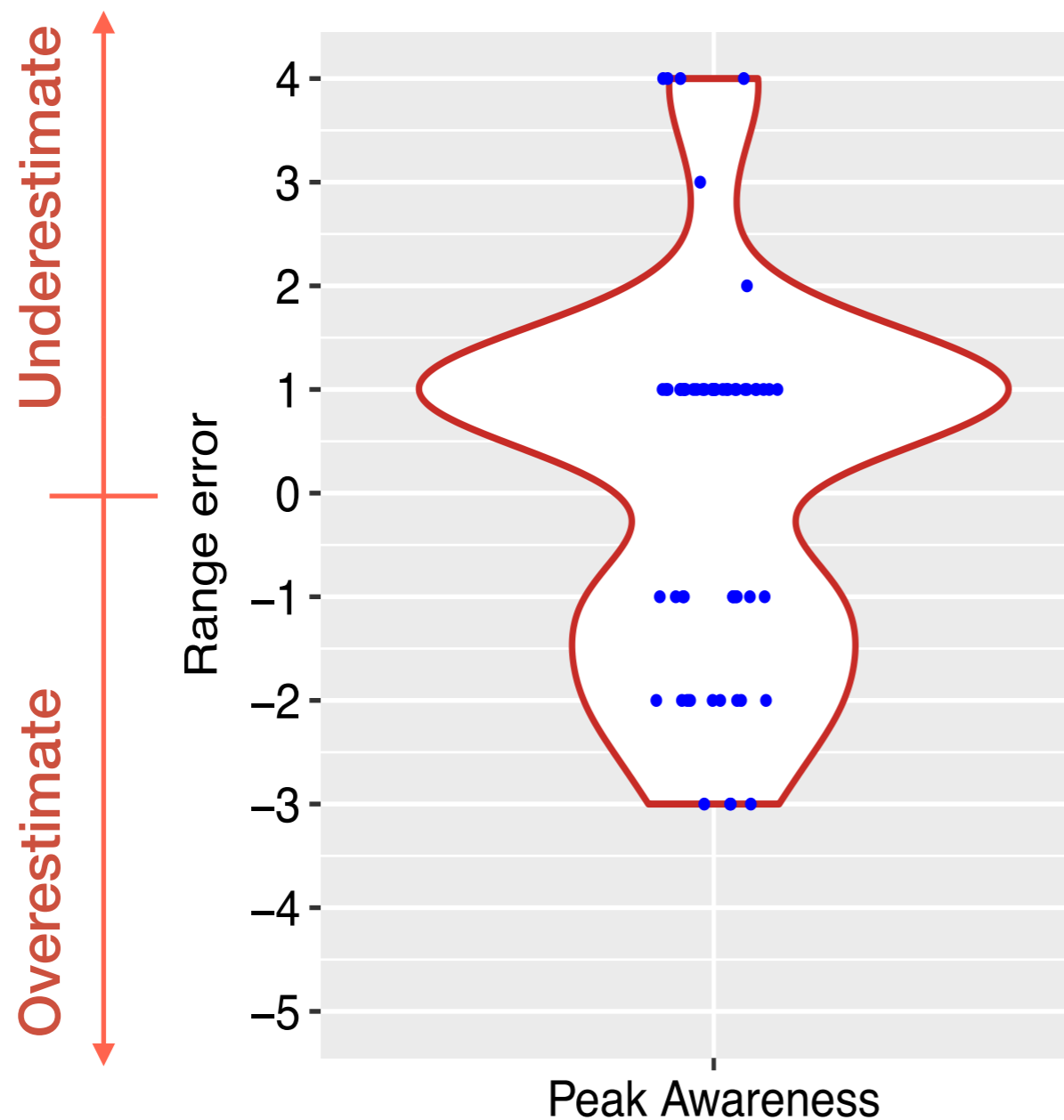
6 PM - 8 PM

Range error:

**-3**



# Difference Between Reality & Consumer's Perception



Peak awareness options:

6 AM - 9 AM

9 AM - 12 PM

12 PM - 6 PM

6 PM - 8 PM

8 PM - 6 AM

Range error:

= Actual range - Response range

Actual range:

6 AM - 9 AM

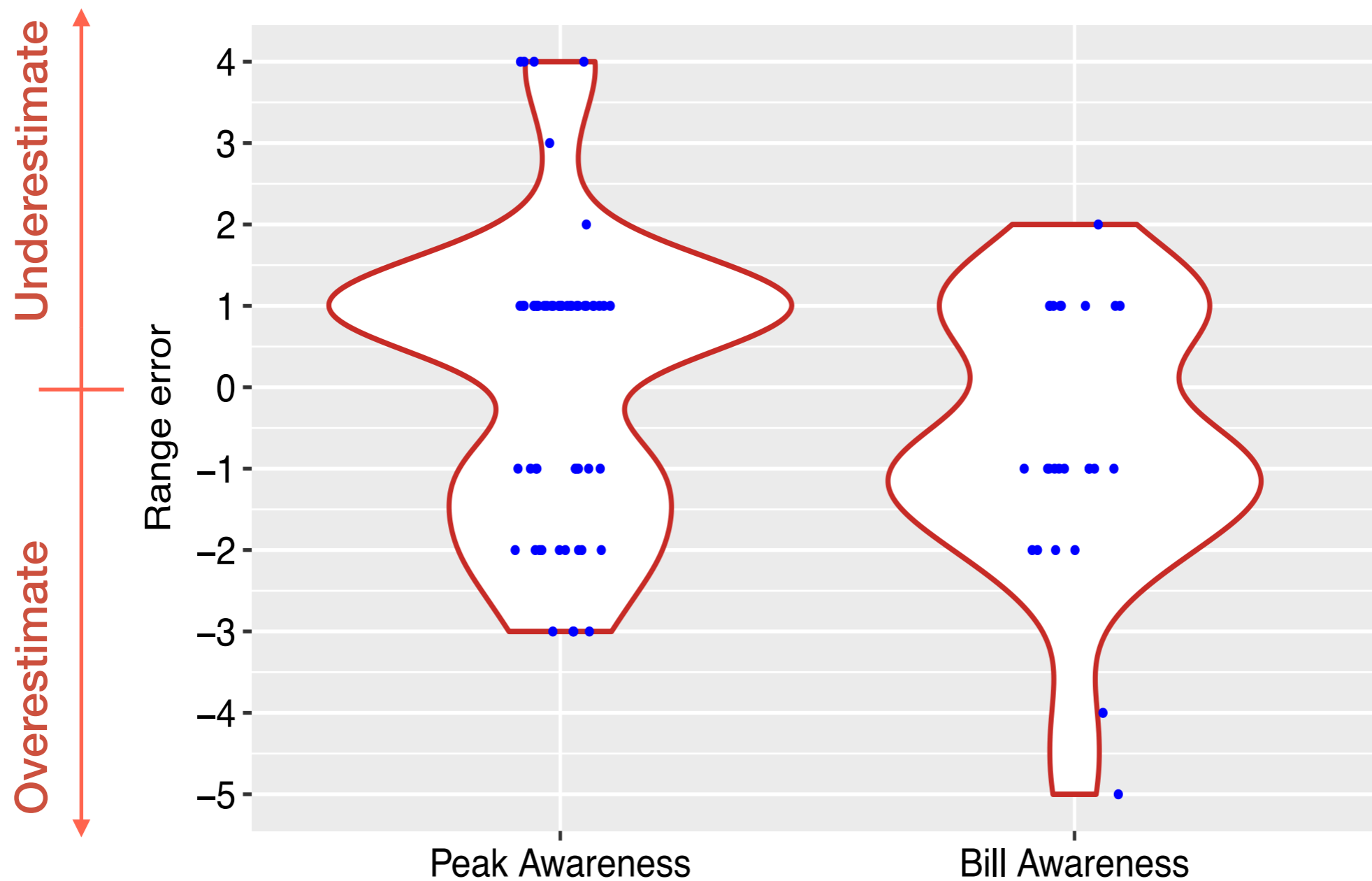
Response range:

6 PM - 8 PM

Range error:

**-3**

# Difference Between Reality & Consumer's Perception



# Possible Reasons for Lower Awareness

- Electricity bill gets deducted automatically
- Consumers see only number of units consumed
  - Detailed feedback improves awareness<sup>1,2</sup>
- Bill is a small fraction of one's salary<sup>3</sup>

1. Counter Entropy: Visualising power consumption in an energy+house, ACM CHI, 2013

2. Is disaggregation the holy grail of energy efficiency? The case of electricity, Energy Policy, 2013

3. Designing persuasive technology to manage peak electricity demand in Ontario homes, ACM CHI, 2015

# The Need: Utilities Should take Lead

- Utilities should improve consumer side efficiency
  - Deploy automated energy efficient approaches on consumer side<sup>1</sup>
  - Take energy reducing measures<sup>2</sup>
    - Replace old appliances with efficient ones
    - Use energy analytics algorithms to identify least efficient consumers

1. Coordinated scheduling of thermostatically controlled real-time systems under power constraint, IEEE RTAS, 2013

2. US energy savings: opportunities and challenges, McKinsey Quarterly, 2010

# Conclusion

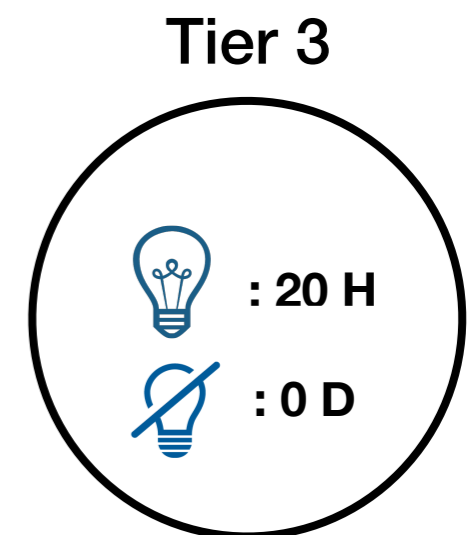
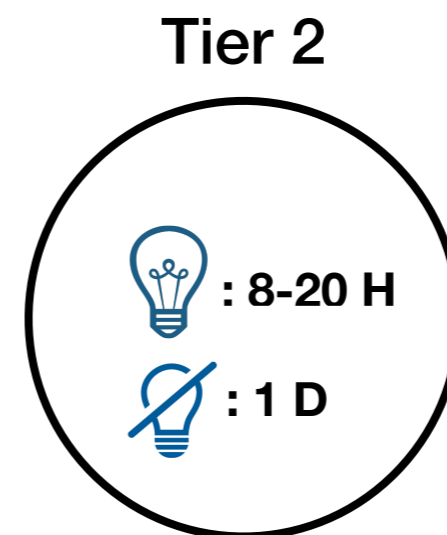
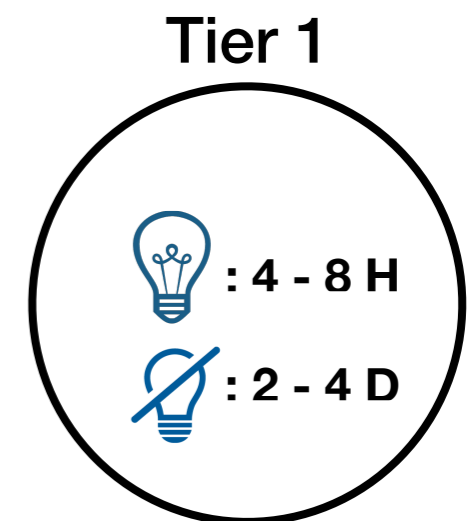
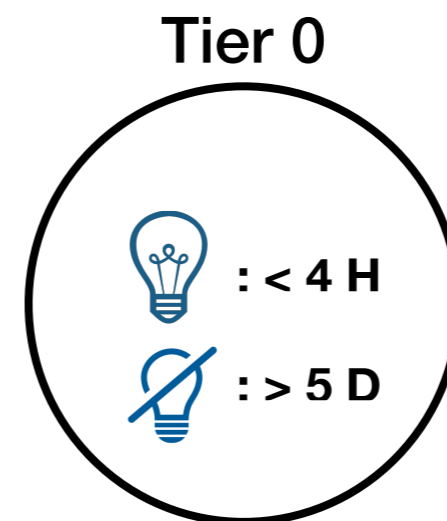
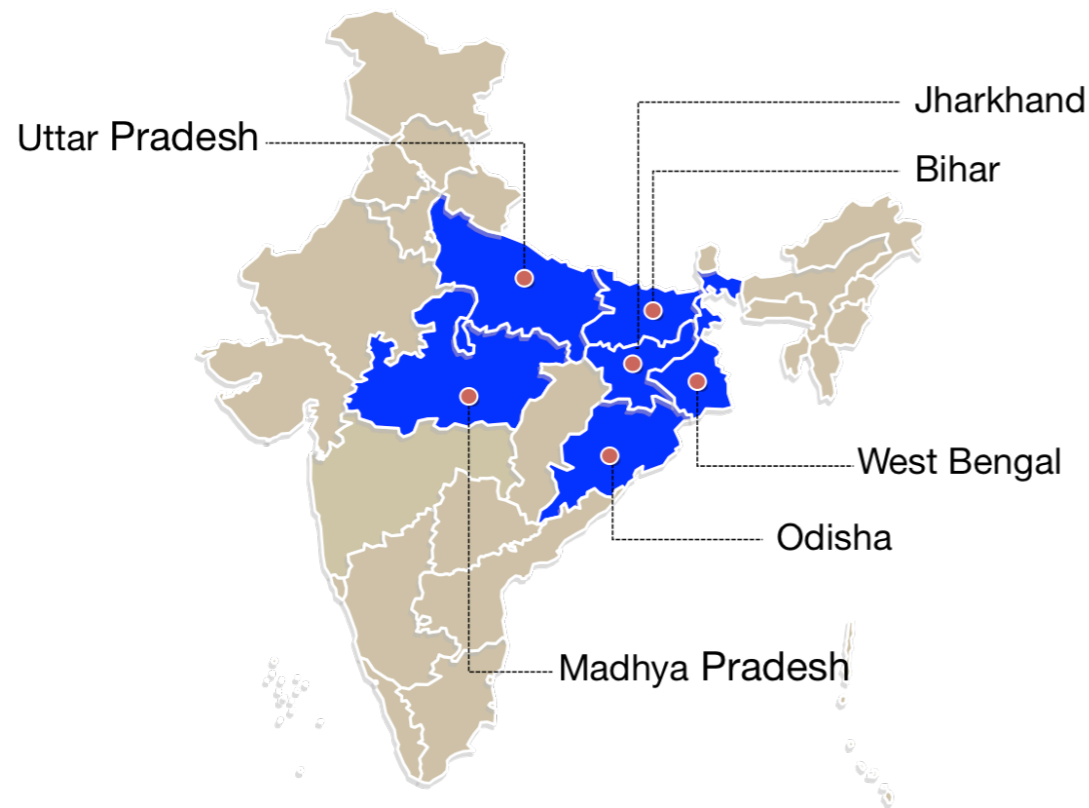
- Middle-class consumers of India are no more energy conscious than Western counterparts
- Electric utilities should take lead in handling societal energy goals through
  - Home automation approaches
  - Energy analytics algorithms



# Next Talk

Help utilities in identifying inefficient consumers

# Appendix

# Energy Deficit



 : Power availability per day (Hours)  
 : Blackouts per month (days)



# Electricity Access Index Across the States

