

What can connected thermostats tell us about American heating and cooling habits?

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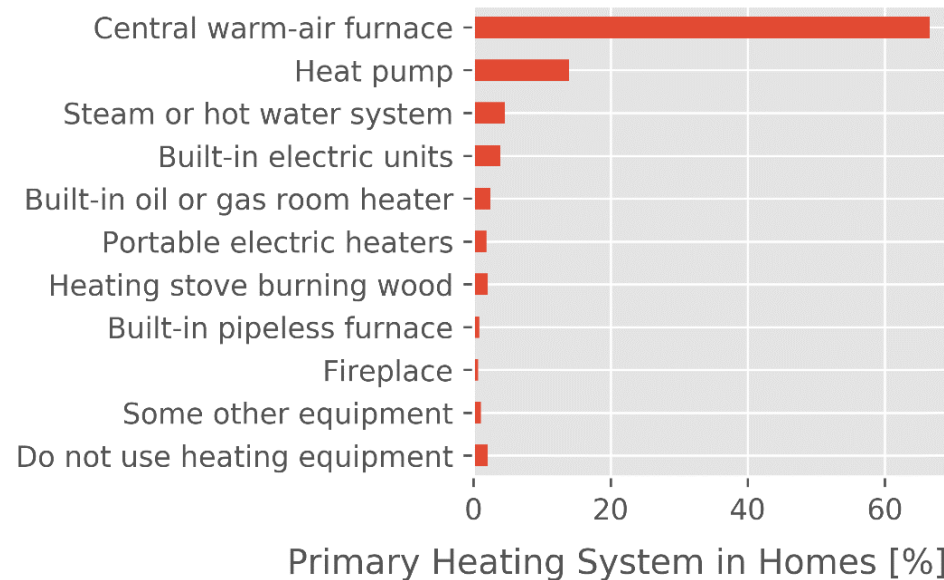
eceee summer study

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Introduction

- ◆ Space heating/cooling is responsible for half of all residential energy use in USA
- ◆ Target for energy-saving actions
 - Reducing envelope losses
 - Raising the efficiency of the HVAC systems
 - Controlling their operation
- ◆ Thermostat is a key element of the control system!

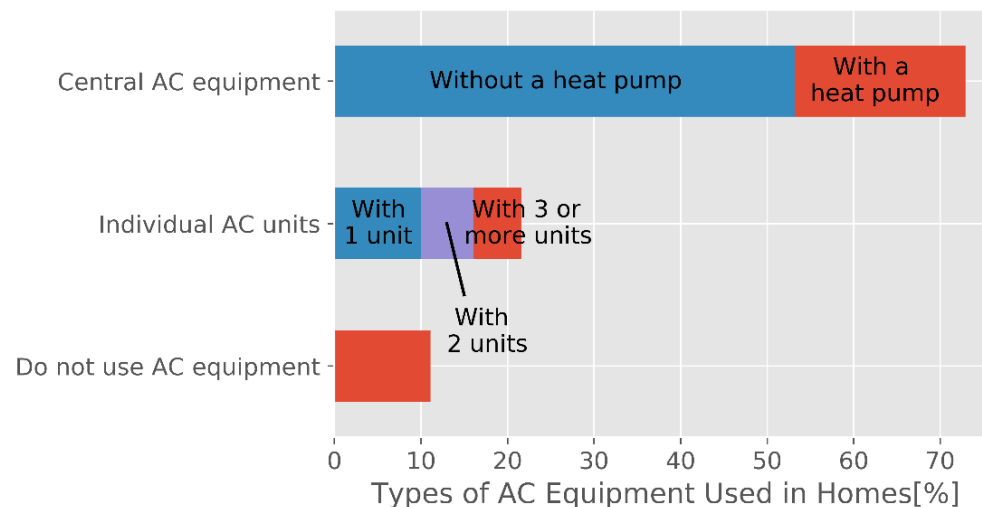
HVAC systems in the U.S.



◆ Central HVAC system is the most popular. And they use “thermostat” for control.

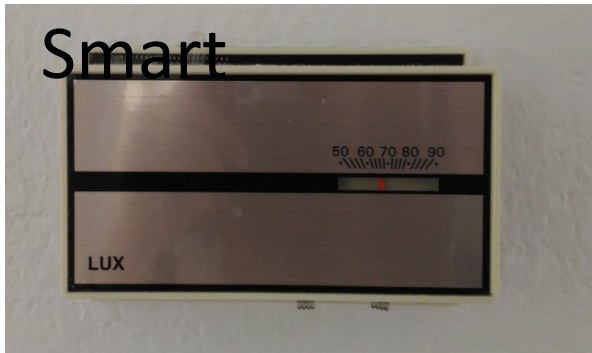
◆ Individual heating units are used in less than 14% of homes.

◆ Individual (or room) AC is about 20%.



What is a Connected Thermostat?

Traditional



Smart

Schedule



Connected/



[Penetration Rate]

25%

50%

4%

[Function]

On/Off

Scheduling

Data Collection

Temperature Setting

(Day/Mode)

Energy-

saving



Started in 2015

Donate your data

Sharing anonymized data from your ecobee smart thermostat can help scientists advance the way to a sustainable future.

JOIN NOW

- ◆ Customers are given the option to “donate” their data during the thermostat registration procedure
- ◆ Data are anonymized but customers are asked to contribute information about home: floor area, city, age of home, etc.

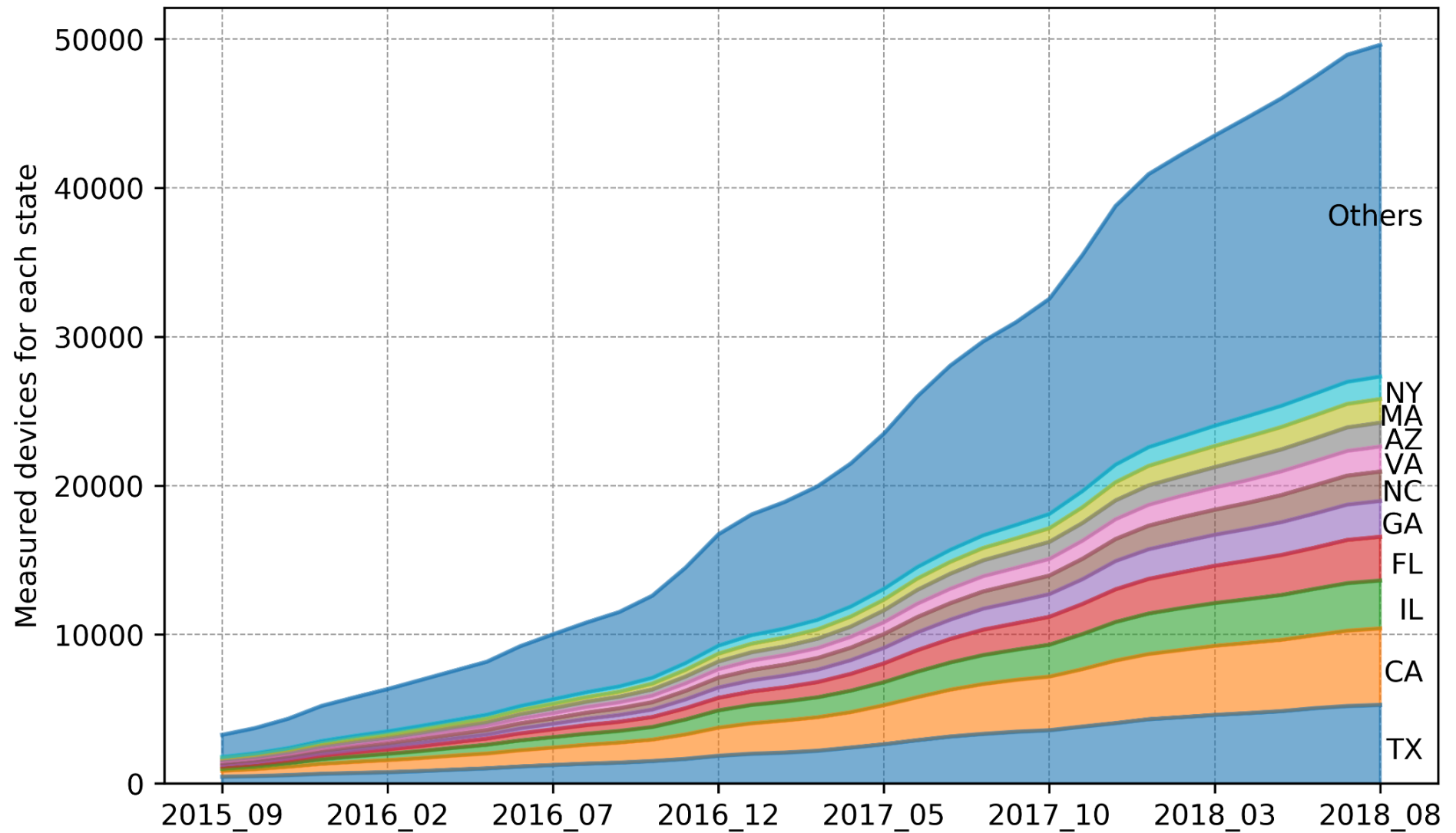
What gets donated?

ecobee gives researchers the following data:

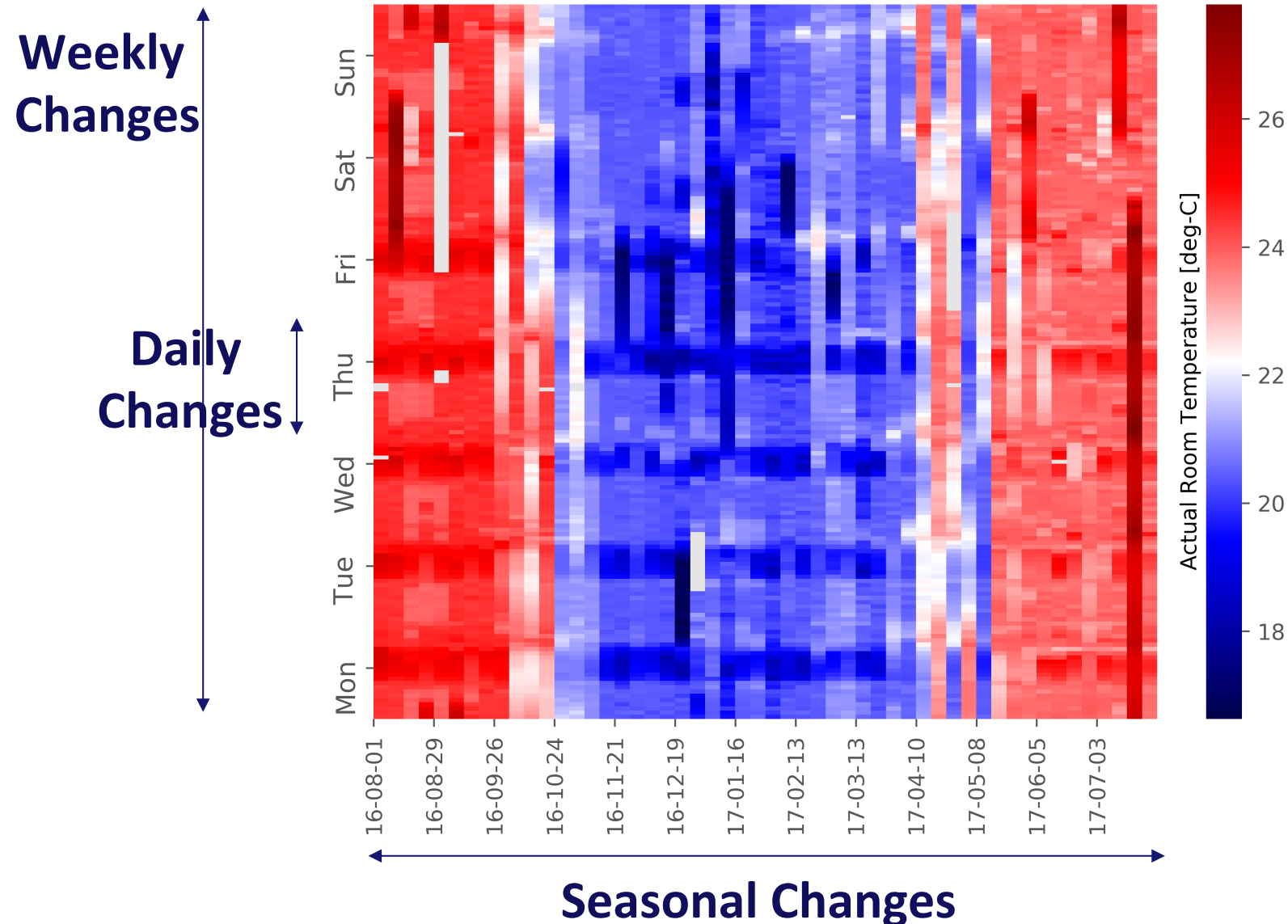
- ◆ Customer supplied metadata
- ◆ 5-minute data for
 - thermostat setpoints
 - Inside temperature(s)
 - HVAC runtime
 - Outside temperature (from weather station)
- ◆ Energy consumption data is not included.



Donations have grown rapidly



Example: room temperature in a house



What can the data tell us about behavior and energy use?

Data from the 20,000 DYD homes let us:

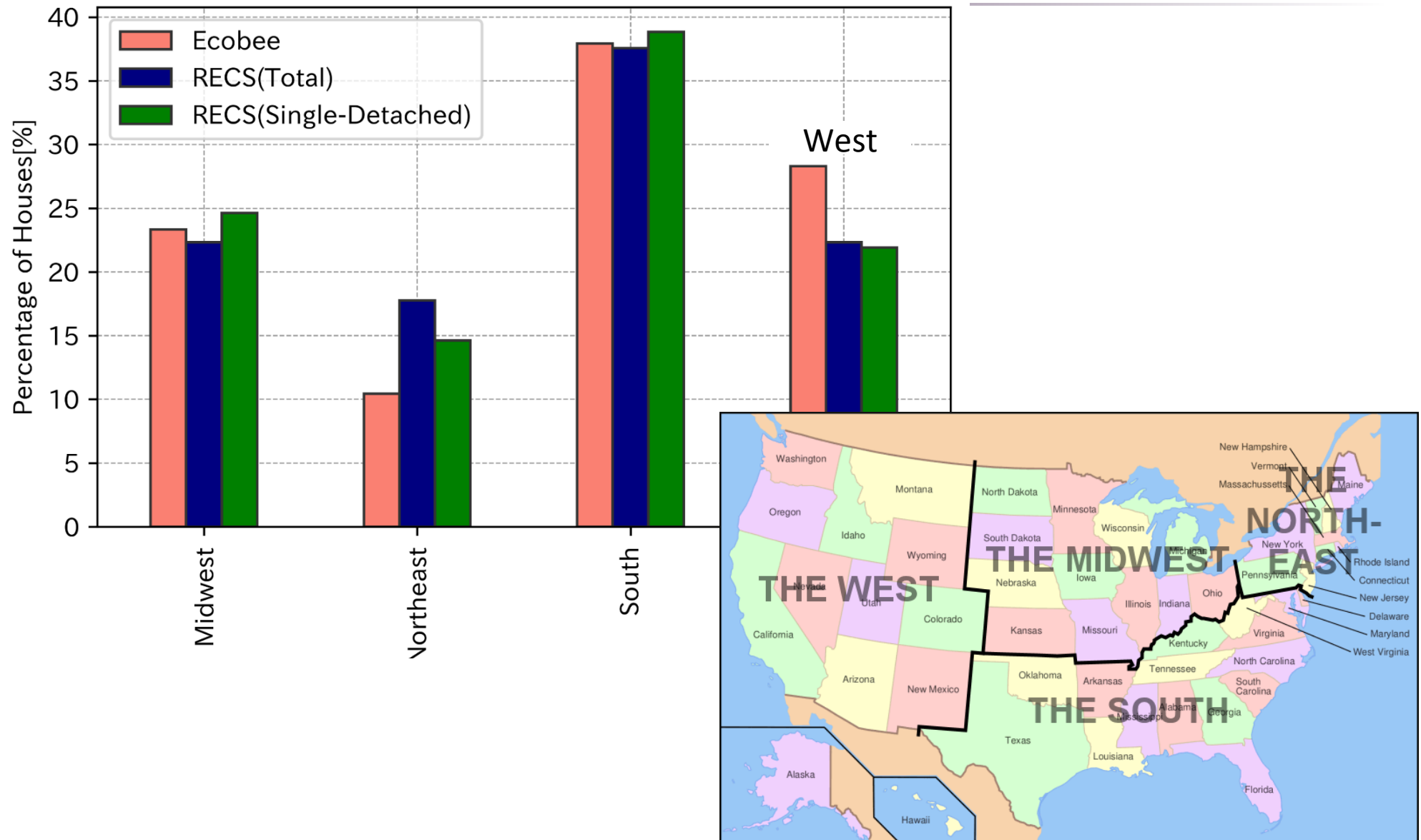
- ◆ Explore HVAC usage that we can't notice from surveys (such as RECS)
- ◆ Detect load peak for heating and cooling
- ◆ Find other insights not possible from other sources

What is the RECS?

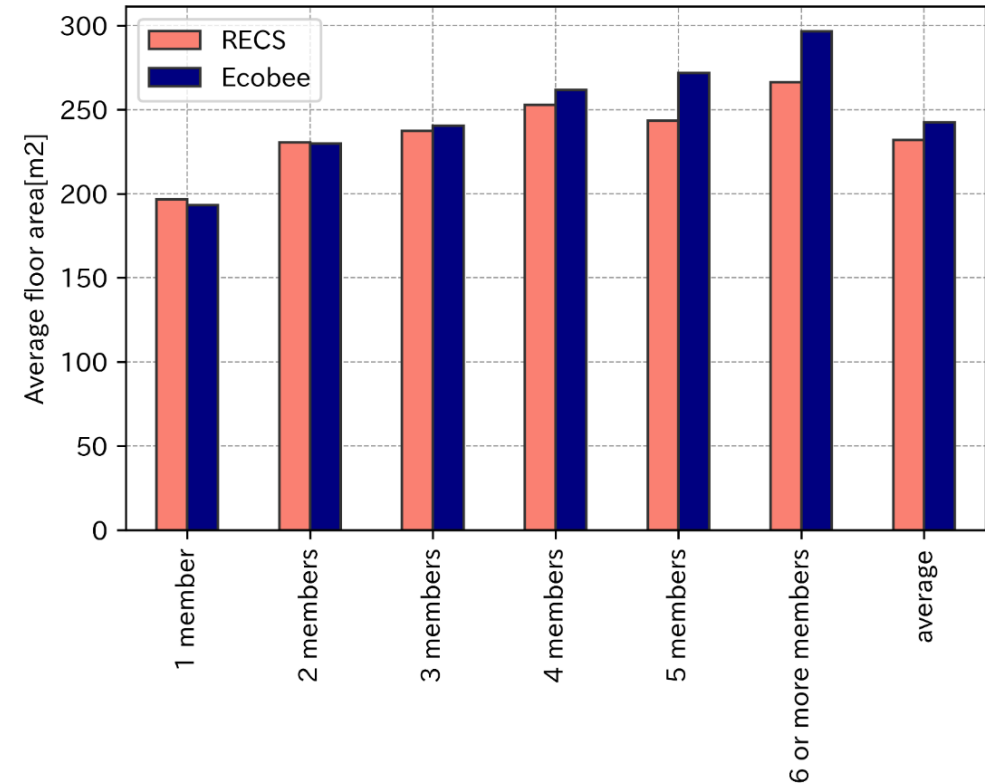
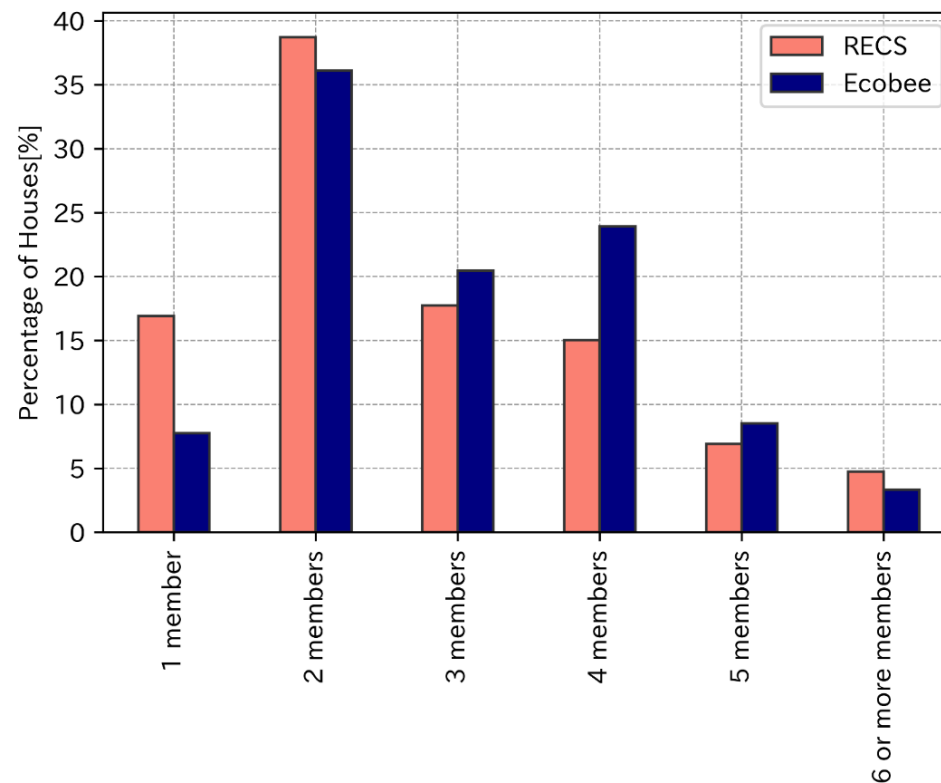
- ◆ RECS: the Residential Energy Consumption Survey
- ◆ Conducted by the U.S. EIA every four years.
- ◆ Gathering information about energy use among houses.
- ◆ Surveyed 6,000 houses for the newest 2015 survey.
- ◆ Space heating, AC, water heating, electric appliances, structural features, and thermostats.
- ◆ Collects energy consumption data from energy companies.
- ◆ Most reliable source of information about U.S. residential energy use.
- ◆ But there are few and simple questions about HVAC usage.

We suspect that the answers are not reliable.

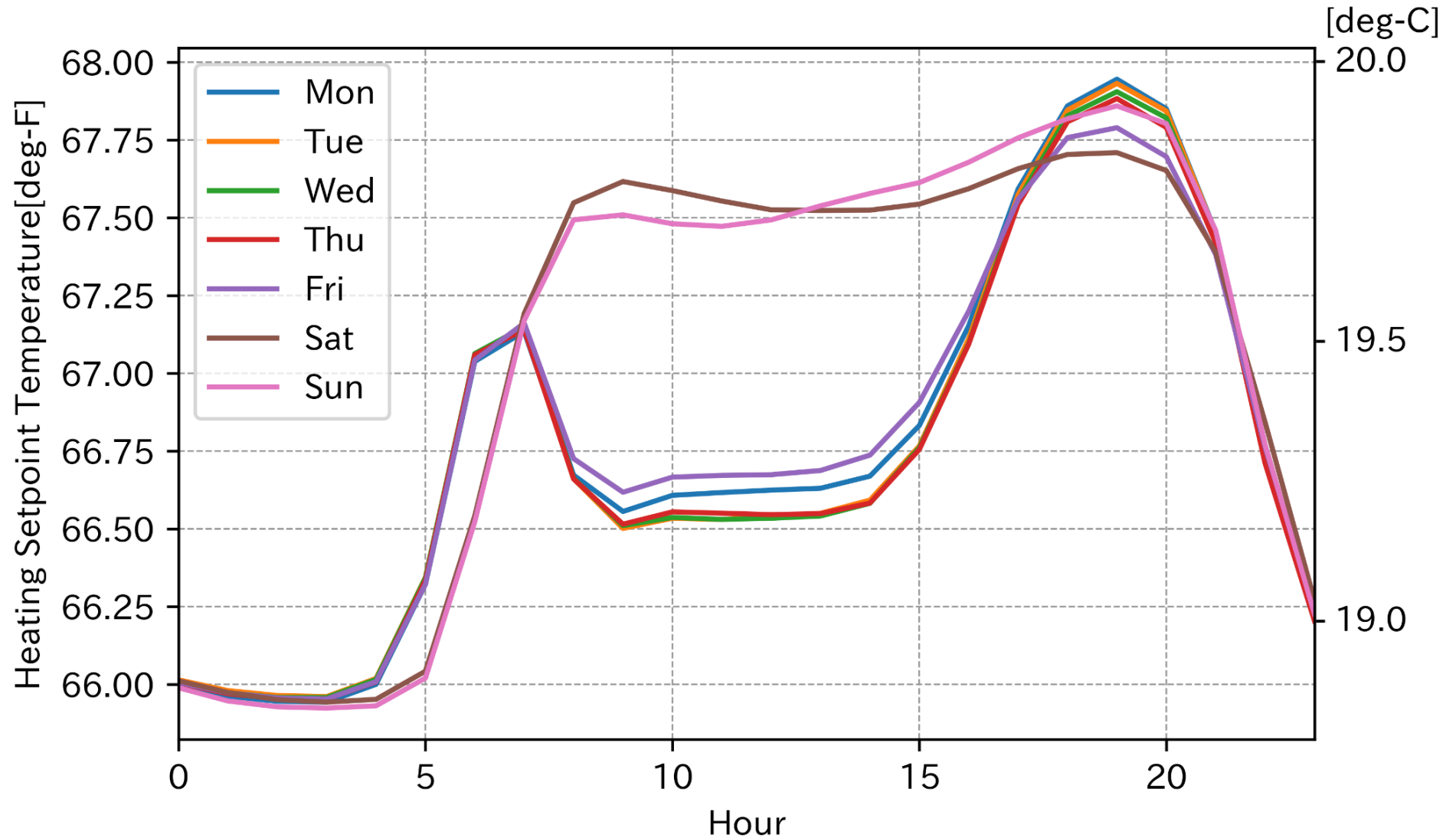
Comparison with the RECS: Region



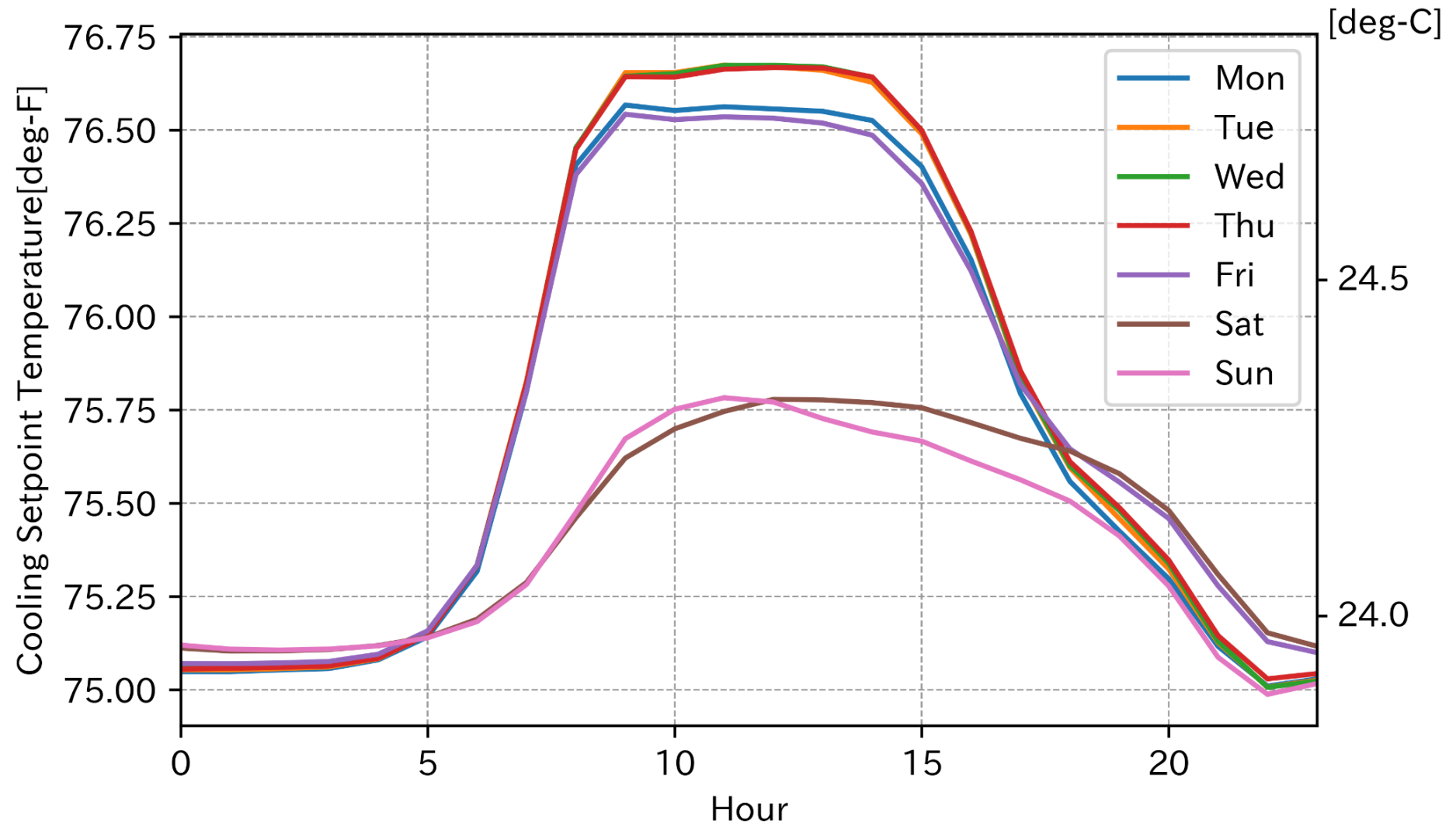
Comparison with the RECS: Members and Floor Area



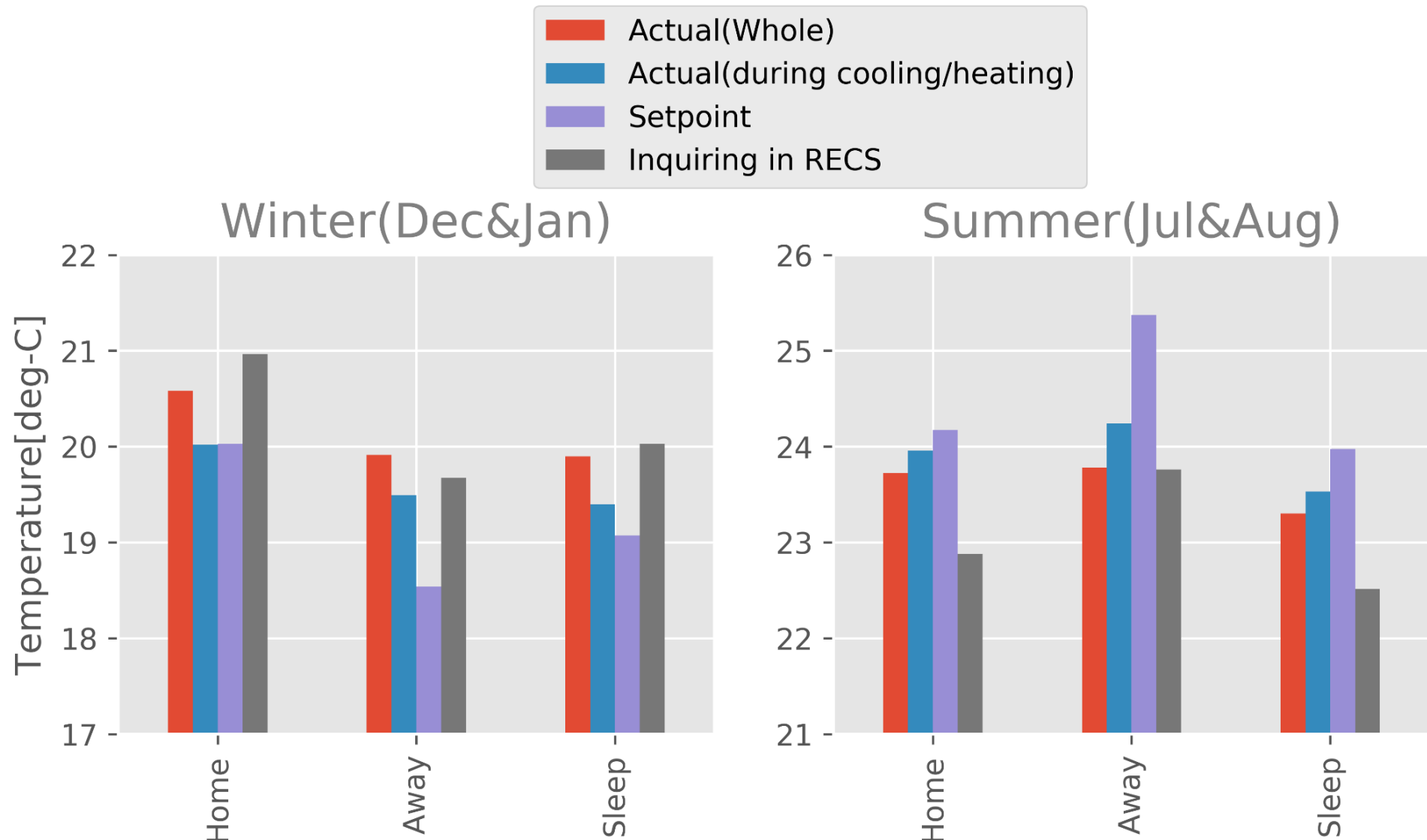
Temperature Settings (heating)



Setting temperature for cooling



Setpoint vs. Actual Room Temp



Result 2

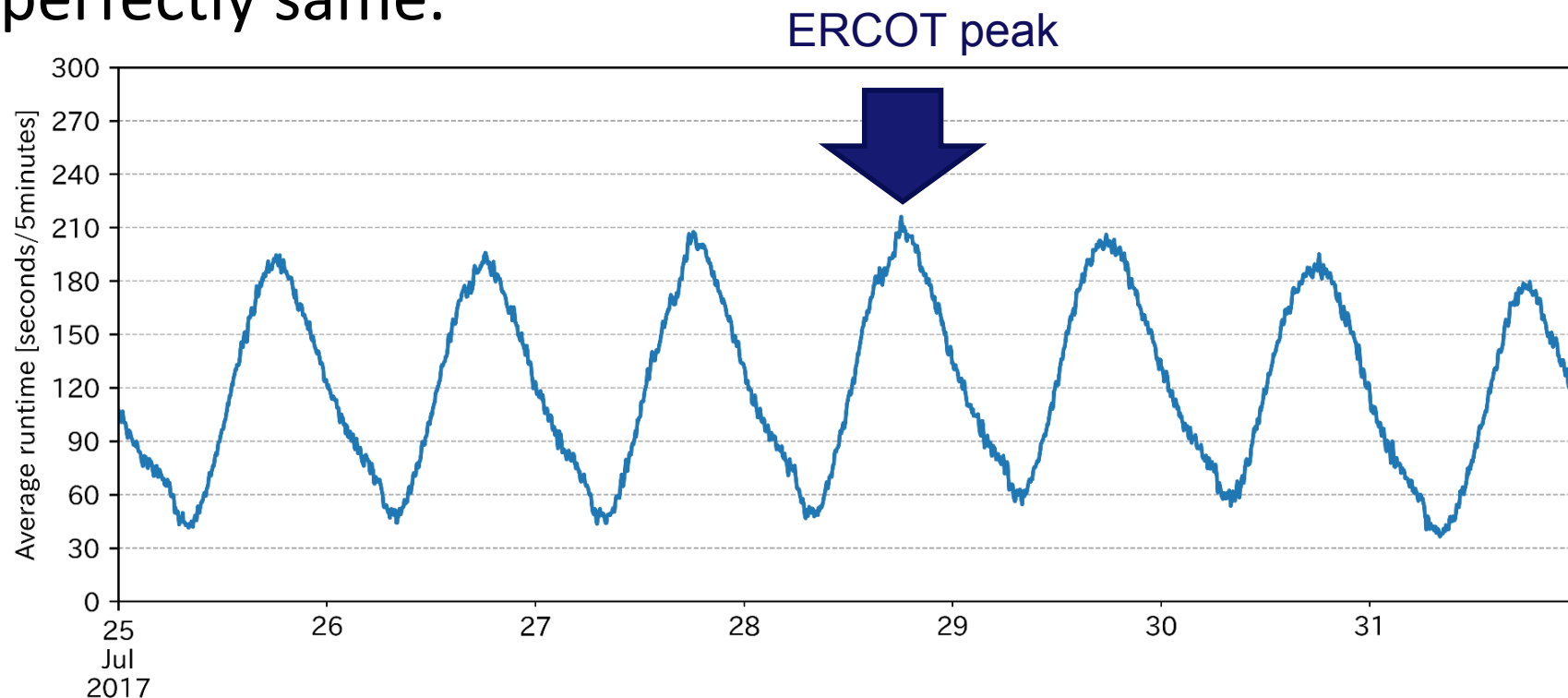
DETECTING PEAK LOAD FOR HEATING AND COOLING

Can we detect load peak from CT data?

- ◆ Obtaining representative hourly load shapes for major end uses is important for energy forecasting but expensive to obtain.
- ◆ Can the run-times of HVAC units explain the load shape?
- ◆ The run-time of each HVAC system must still be converted into power before it becomes a load curve.

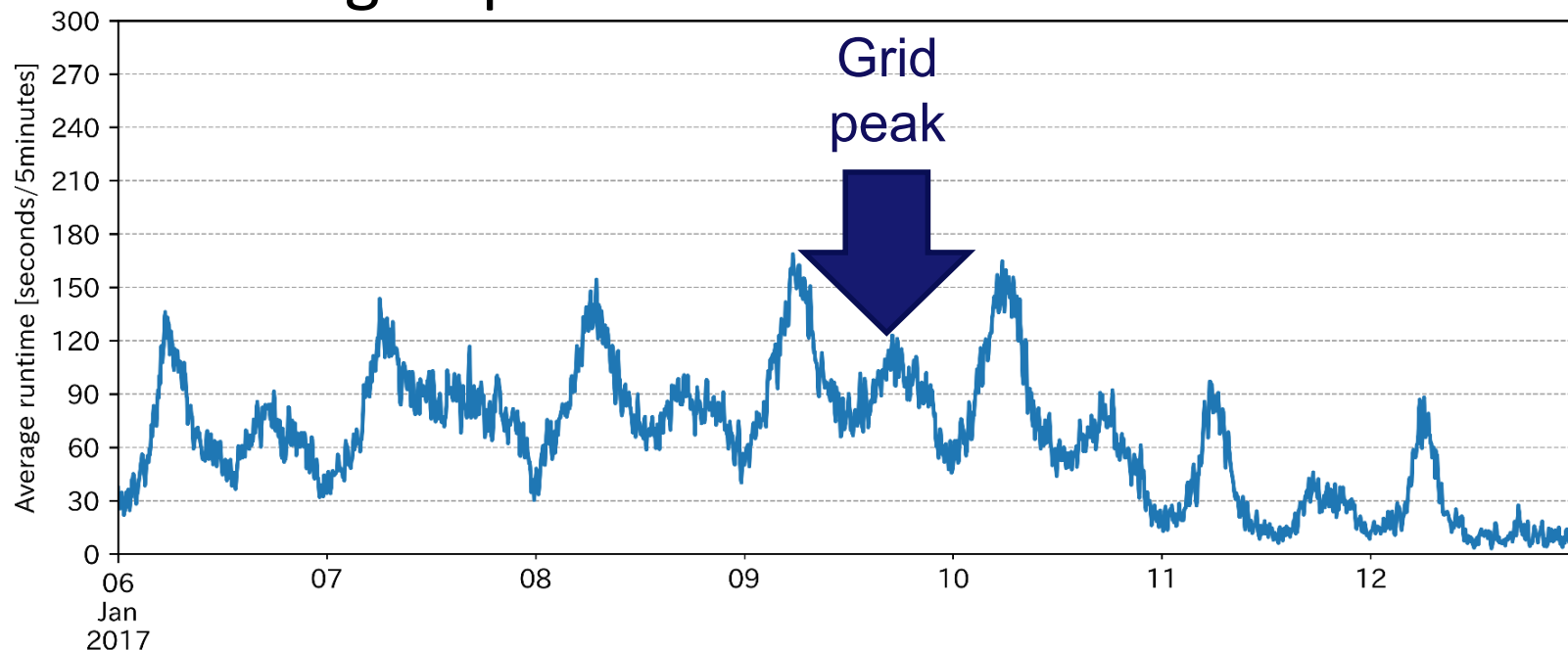
Load peak day in summer (Texas)

- ◆ Facts: ERCOT's summer-to-date peak load stood at 69.5 GW, set on July 28th from 5-6 pm.
- ◆ Peak Date / Time of the grid and ECOBEE run-time were perfectly same.



Winter peak load day (Massachusetts)

- ◆ The grid operator for Massachusetts experienced its peak demand at 18:00–19:00.
- ◆ Peak Time of ECOBEE occurred in the morning.
- ◆ In this case, the peak load of the residential heating didn't influence the grid peak.



Result 3

WHAT THE DYD DATASET CANNOT TELL US

Usefulness and Limitations

Useful:

- ◆ Occupancy Patterns
- ◆ Detect Power Outages
- ◆ Estimate equipment Sizing
- ◆ Analysis with simple investigation
 - ◆ Floor area
 - ◆ Age of home
 - ◆ Number of the occupants

Limitations

- ◆ No energy data
- ◆ No HVAC system input ratings
- ◆ Customer's privacy must be assured
- ◆ Ecobee will protect its commercial value
- ◆ More complex Analysis such as
 - ◆ the impacts of the number of children, babies, elderly
 - ◆ household income
 - ◆ The levels of thermal comfort

Thank you!

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