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Enabling Technology Development Project Workshop

People and Energy at Home: Information Display and Thermal Comfort Development for Residences

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Outline

- Background
- In Home Energy Information Display
  - What? How? For whom?
- Thermal Comfort
  - How are people using thermostats now?
  - How to improve (usability, features, controls)
- Next steps

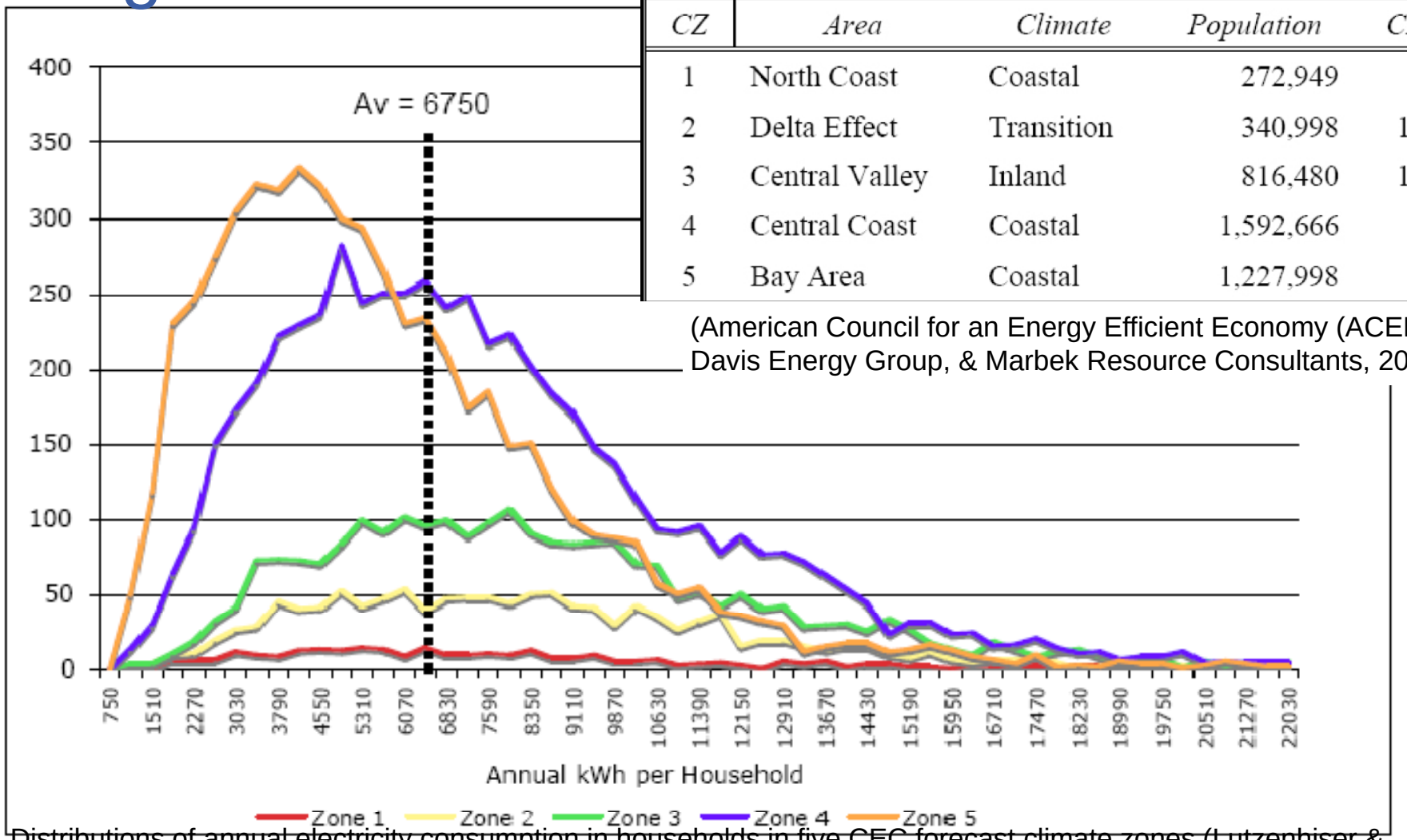
Background

- Demand Response Enabling Technology Development
  - residential/small commercial
  - sensors, actuators, wireless communication, thermostats
- Problem: Wide variability in residential energy
  - Heating and cooling energy
  - Various appliances
- Opportunity: lots of data
  - How to make usable and motivating to reduce peak?
    - Types of graphics? Advice?
  - Improve on existing thermostats
    - “Thermobile” instead of thermostat

Background

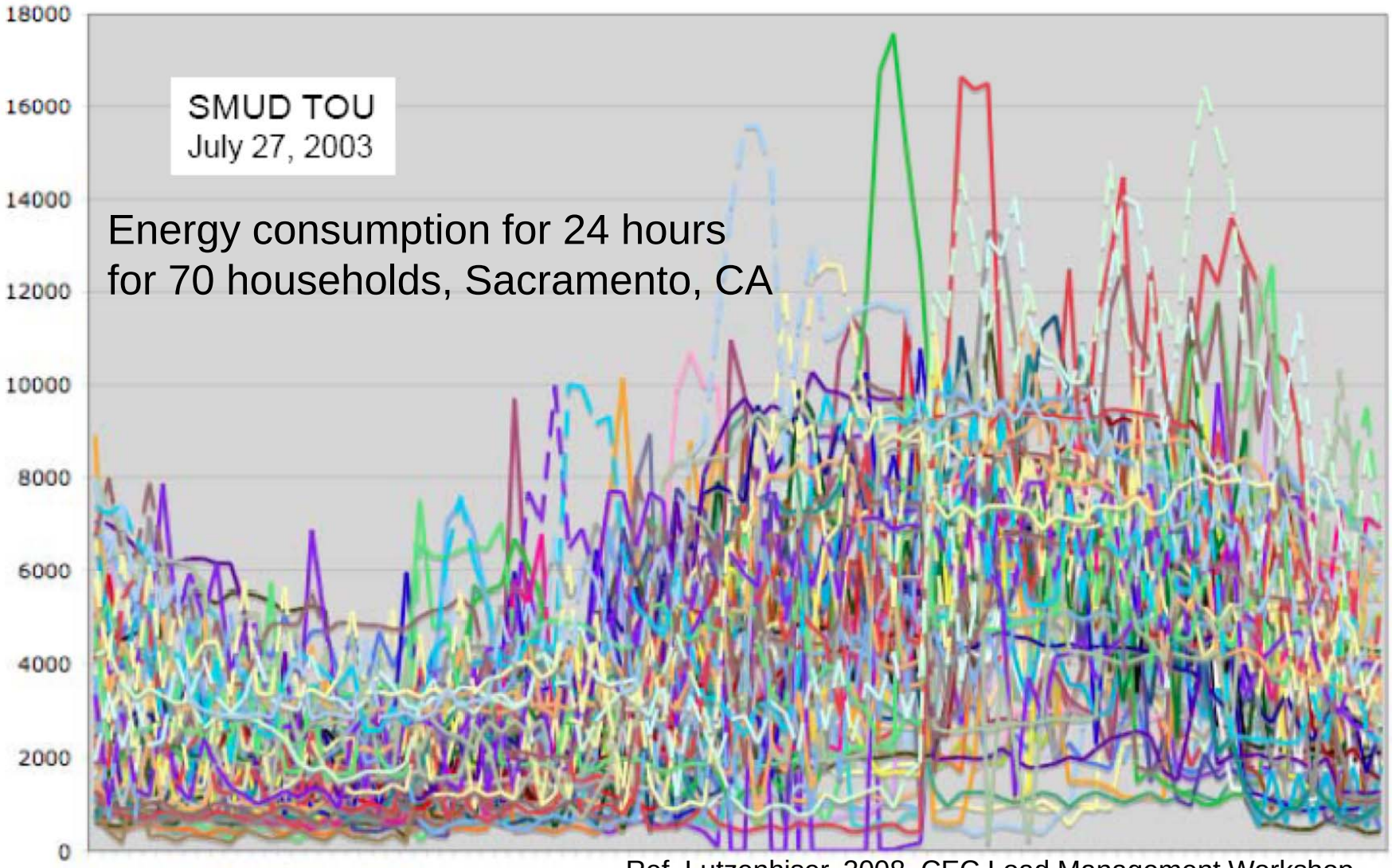
CZ	Area	Climate	Population	CDD
1	North Coast	Coastal	272,949	767
2	Delta Effect	Transition	340,998	1,173
3	Central Valley	Inland	816,480	1,880
4	Central Coast	Coastal	1,592,666	619
5	Bay Area	Coastal	1,227,998	133

(American Council for an Energy Efficient Economy (ACEEE), Davis Energy Group, & Marbek Resource Consultants, 2004)



Distributions of annual electricity consumption in households in five CEC forecast climate zones (Lutzenhiser & Bender, 2008)

Background



Ref. Lutzenhiser, 2008, CEC Load Management Workshop

Information Display

- Use feedback to reduce energy consumption
- How to motivate people?
  - Different attitudes, values, lifestyles
- Display what?
  - Cost? Consumption? Carbon? Polar bears?
  - At what level of detail?

Information Display

- Pilot studies
  - FL pilot: high users reduce most
  - 100 watt resolution does not provide enough detail
  - Detailed end use (appliance use) compelling

Information Display

- Review literature on psychographic segmentation
  - **SRI VALS:** Innovators, Thinkers, Believers, Achievers, Strivers, Experiencers, Makers, and Survivors
  - **Climate change:** The Choir, The Congregation, The Heathen, and The Atheists.
  - **Ontario Power Authority:** Live4Today, Budget Driven, Pragmatic Conservers, Green Champions
  - **BC Hydro:** Tuned-Out and Carefree, Stumbling Proponents, Comfort Seekers, Entrenched Libertarians, Cost-Conscious Practitioners, and Devoted Conservationists.
  - others….

Information Display

- Common themes:
  - Economics
  - Willingness to change
  - Priority of energy consumption compared to other values
  - Social influences
  - Libertarians
  - Interested but need…? Prodding, examples, more information

Information Display

- Other issues: How to display?
  - Aesthetics
  - Ease of use
  - Income level
  - Comfort with technology

Next Steps

- Develop prototype displays and survey
- Test in lab

Thermal Comfort

- Evaluate existing thermostats
  - What types of thermostats do people use?
  - How do they use them?
  - What features are used or not used?
  - What do people want in a thermostat?

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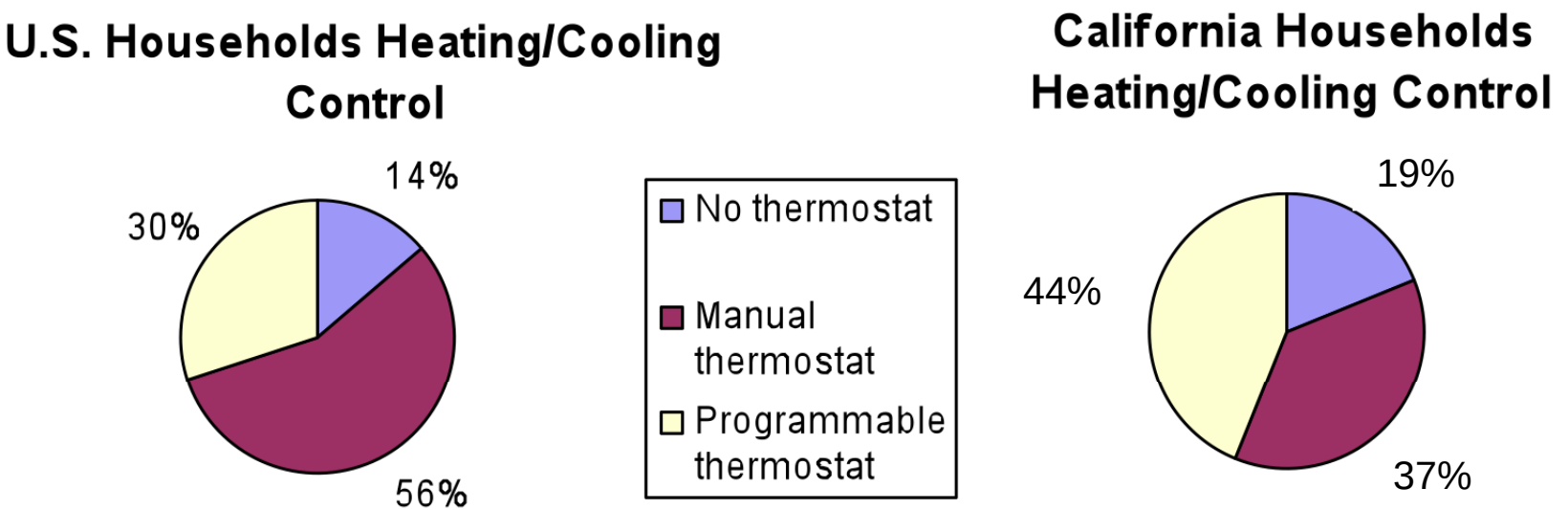
Thermal Comfort

- What types of thermostats do people use?
- Depends on how you ask the question!
  - "Programmable"
    - Setback/clock
  - Manual (standard, mechanical, or electronic, analog or digital)

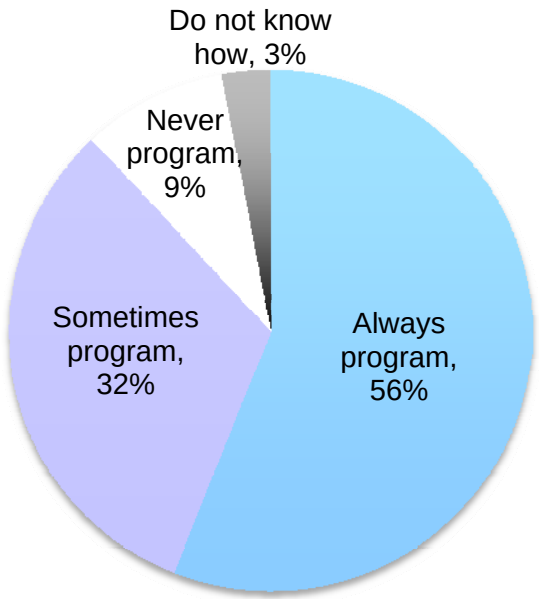
Thermal Comfort



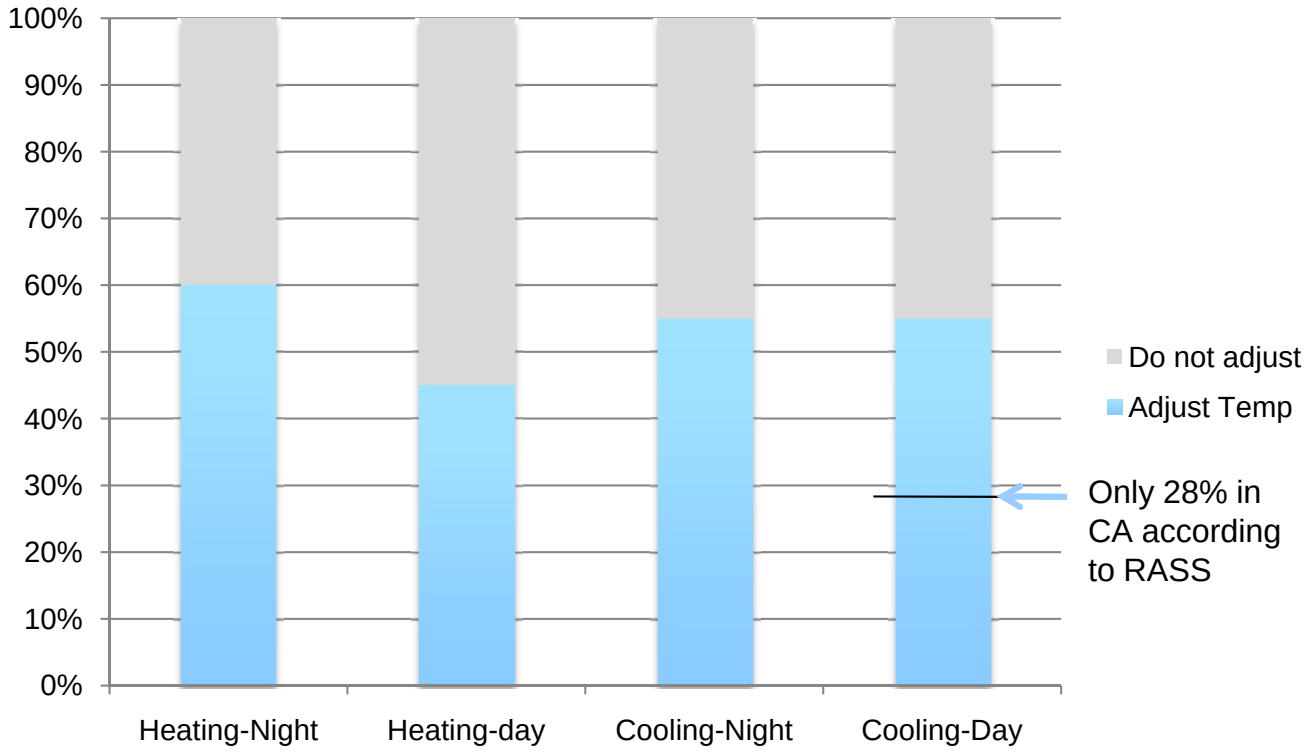
from data in (Energy Information Administration (EIA), 2005).

Thermal Comfort

- How do people use thermostats?
  - About half of the households with programmable thermostats use them to adjust temperature for savings.



from data in (Decision Analyst, 2009).



from data in (Energy Information Administration (EIA), 2005).

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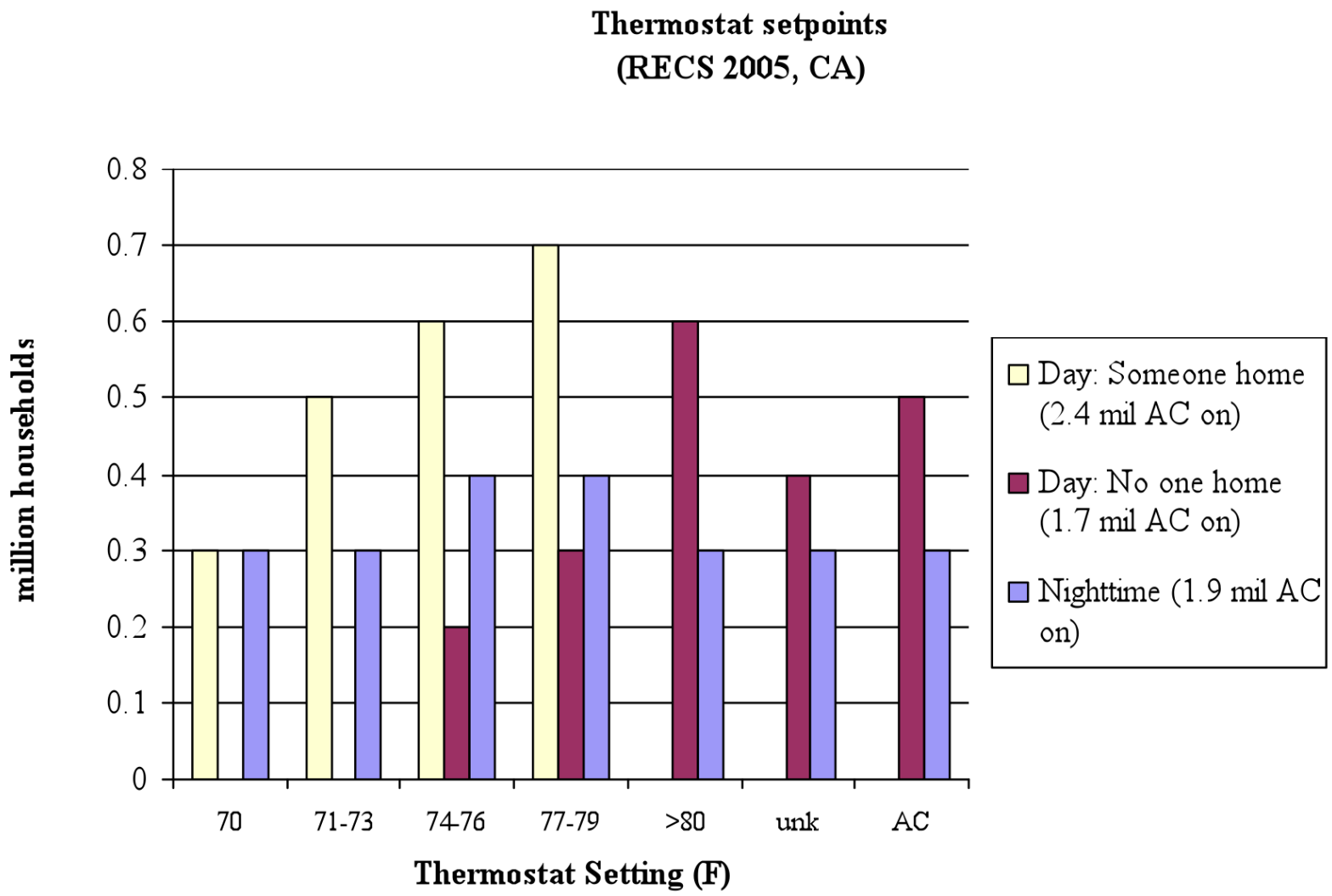
"Research Powers the Future"

Usability issues

- "Thermostat settings do not meet the comfort needs of programmable thermostat owners…household do not know how to program their thermostats" pp. V.251, vol 2. American Home Comfort Survey
- Of people reporting not saving energy, ~1/3 usability issues (difficulty programming, not programmed correctly, did not know how to program)
- Recent low income study: many in hold mode
- Recent usability tests of four thermostats with 31 subjects, seven tasks:
  - task 1: turn system to Heat
    - one-third could not complete
    - average time to complete: 31 seconds (longest: nearly 5 min)


Thermostat setpoints
(RECS 2005, CA)
million households
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
70
71-73
74-76
77-79
>80
unk
AC
Thermostat Setting (F)
Day: Someone home (2.4 mil AC on)
Day: No one home (1.7 mil AC on)
Nighttime (1.9 mil AC on)
AC off

Use cases

Regular

Temperature preferences based on Daily, weekly, monthly patterns, outdoor temperature, cost, swimming pool

No pattern, use of on-off switch, time, number-centric, use thermostat like valve, “fiddlers”, based on occupancy in different parts of house

Habitual

Grandma visit, bathtime, come in from run/exercise, leave to run errands,

Sporadic

Party, at home sick, business trips, go fishing/skiing for the day, thermostat wars between different household members, when puppies born, growing plants

Next steps

Analyze survey data (http://hes.lbl.gov/consumer/)

Mine thermostat databases

Develop algorithms and suggested other controls

Test

Questions?

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