SMUD Thermostat Usability Study

Vikki Wood

OpenADR Alliance Meeting

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Powering forward. Together.

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Agenda

- About SMUD
- Research Plan
  - Background
  - Research Design
  - Approach
- Analysis and Ranking
  - Efficiency
  - Preference
- Features and Recommendations

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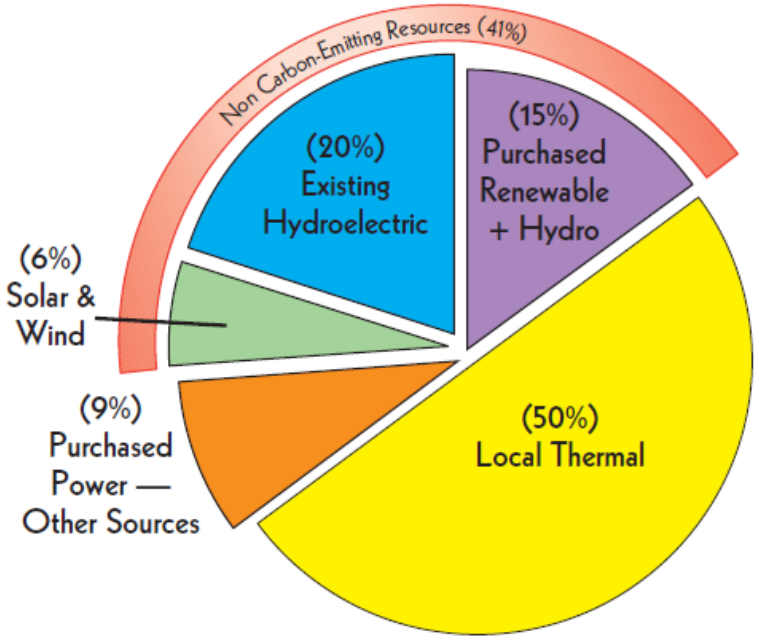
About SMUD

- SMUD is a public electric utility serving ~ Sacramento County, CA
- Governed by a seven-member elected Board of Directors (not regulated by CPUC)
- ~600k customer-owners, 530k residential, 70k commercial, 1.4M population, 900 mi^2
- Summer system peak ~3,000 MW
- Very proactive in promoting energy efficiency and renewable resources



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Problem Identification

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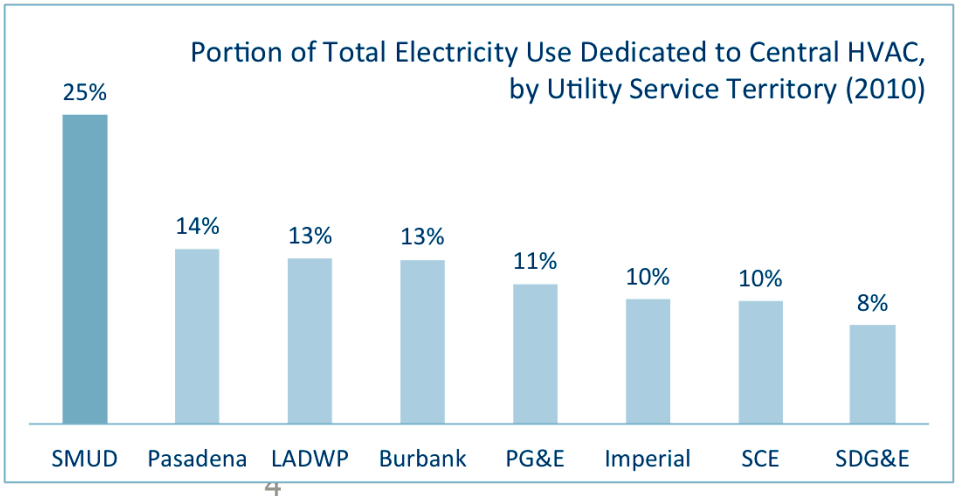
- Thermostats manage ~25% of electricity consumption
- Residential AC responsible for about 1/3 of total 3,000 MW peak demand



Source: California Energy Commission, 2009.

Industry

- Design inconsistent with thermostat use goals
- Industry has moved beyond the standard programmable thermostat to the smart thermostat
- Title 24 standards are moving toward requiring smart thermostats

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Research Objectives

Primary Goal

Assess features and functions of a variety of thermostats to determine which characteristics might be recommended or required in specifications for thermostats promoted by or implemented for future programs at SMUD.

Study Objectives

- Develop, calculate and compare usability metrics for a sample of new thermostats
- Determine preferences for advanced thermostat features
- Identify specific design concerns

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Research Questions

1. How do performance efficiency metrics compare between products?
2. How do satisfaction metrics compare between products?
3. How do participants rate the advanced features they reviewed?
4. What features are most helpful to users in completing common tasks?
5. What flaws prevent users from completing common tasks?
6. How do products rank in order of which is chosen most often as the favorite?

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Methodology

Simultaneous, multi-user, paired comparison test of thermostats for:

1. Task efficiency
2. Thermostat preferences
3. Perceived usefulness of advanced features

- 163 residential customers
- 90 minute sessions
- 12 thermostats
  - 10 PCTs
  - 6 with web access
- 326 individual tests
  - All 66 pairs tested
  - 126 of 132 ordered pairs tested
- Video recording, surveys, and focus groups

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Approach

- Each participant tested (and compared) 2 thermostats
- To avoid order bias, each thermostat was the *first* unit tested in roughly half of the tests, and the *second* unit tested in the remaining tests
- Testing protocol
  - Participants were briefed on the study
  - Participants were given a series of common thermostat tasks to complete—they marked each task complete or not
  - Participants were videotaped performing the tasks
  - Following the tasks participants filled out a survey on thermostat
  - Following the survey, participants gathered to discuss their experience
  - These steps were repeated for the second thermostat
  - After the second thermostat test, survey and discussion, participants filled out a third survey comparing the two thermostats

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Thermostats Tested

Lux Smart Temp

Honeywell FocusPro

RCS TZ-45

Radio Thermostat CT30

Nest

Computime CTW218

Carrier Comfort Choice Touch

Ecobee Smart Si

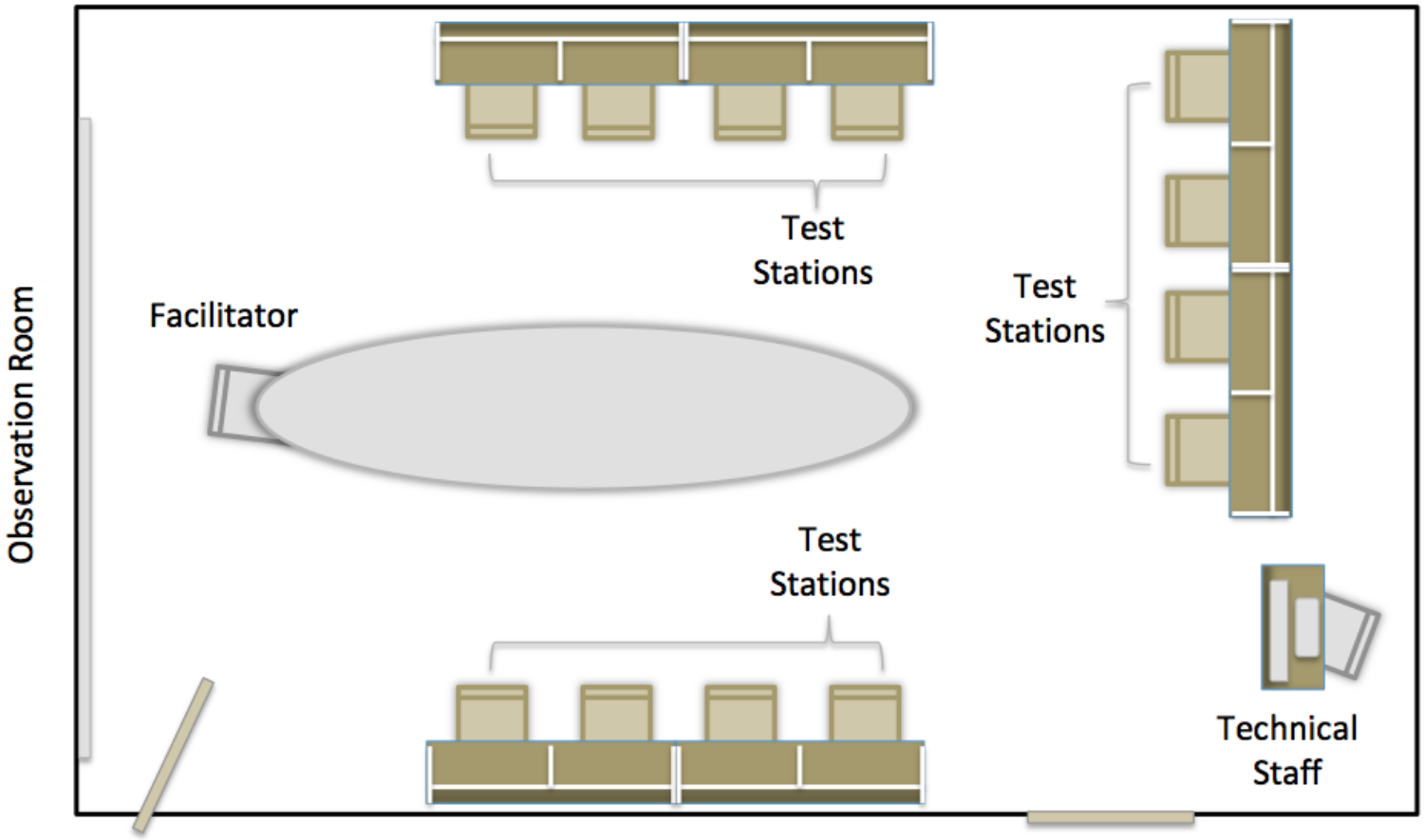
Energate Foundation FZ100

Energate Pioneer Z100

Cooper-Honeywell Utility Pro

Emerson Evolv

Laboratory Layout



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User Tasks

Task	Task Booklet A
1	Identify the current indoor temperature
2	Set to cool. Identify the current target cooling temperature.
3	Change the current target cooling temperature to 79
4	Identify the scheduled cooling temperature for Saturday at 8 am
5	Set to heat. Identify the current target heating temperature.
6	Change the current target heating temperature to 63
7	Identify the scheduled heating temperature for Saturday at 8 am
8	Advanced task 8A
9	Advanced task 9A

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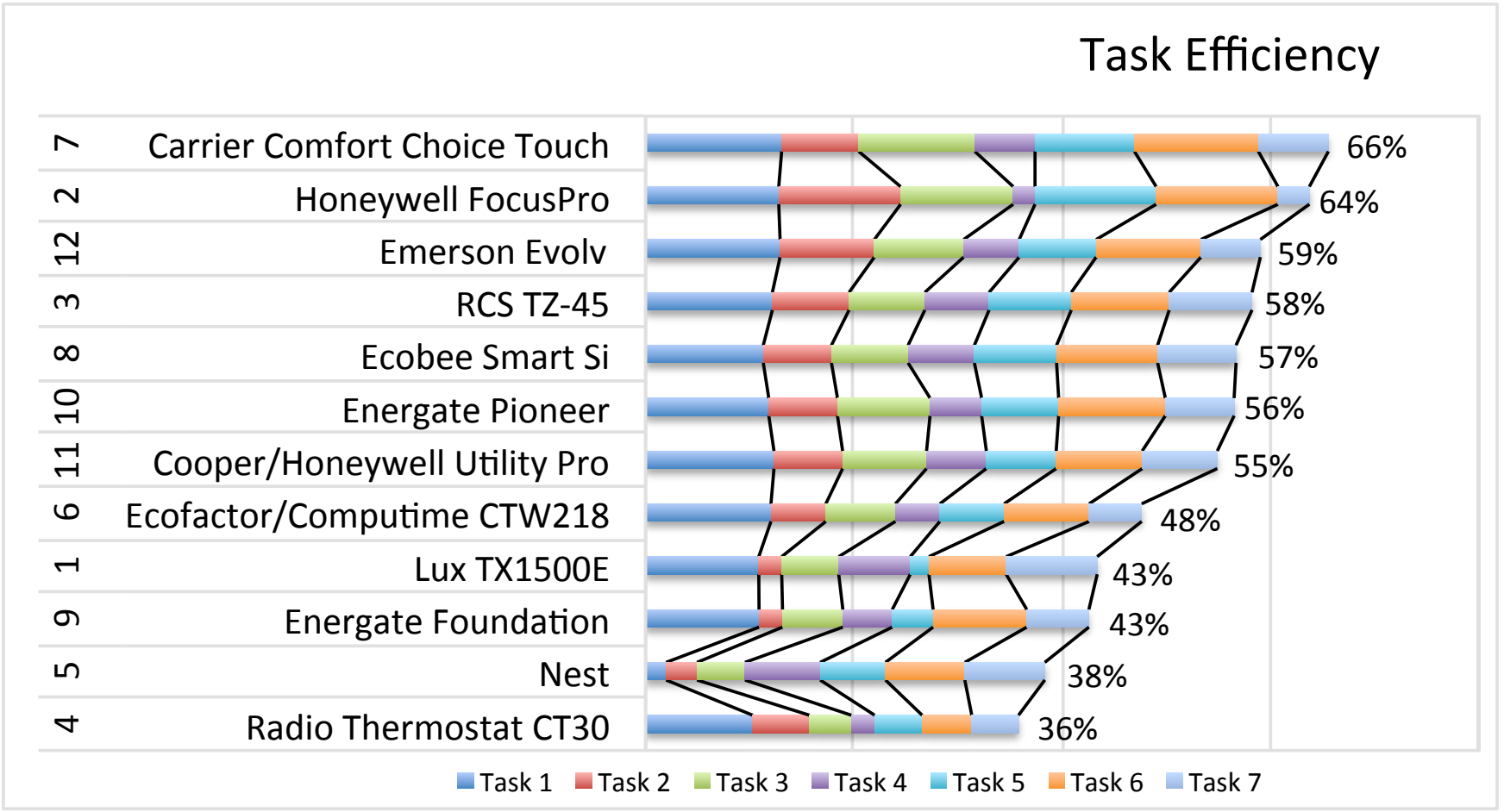
Results

Results: Efficiency



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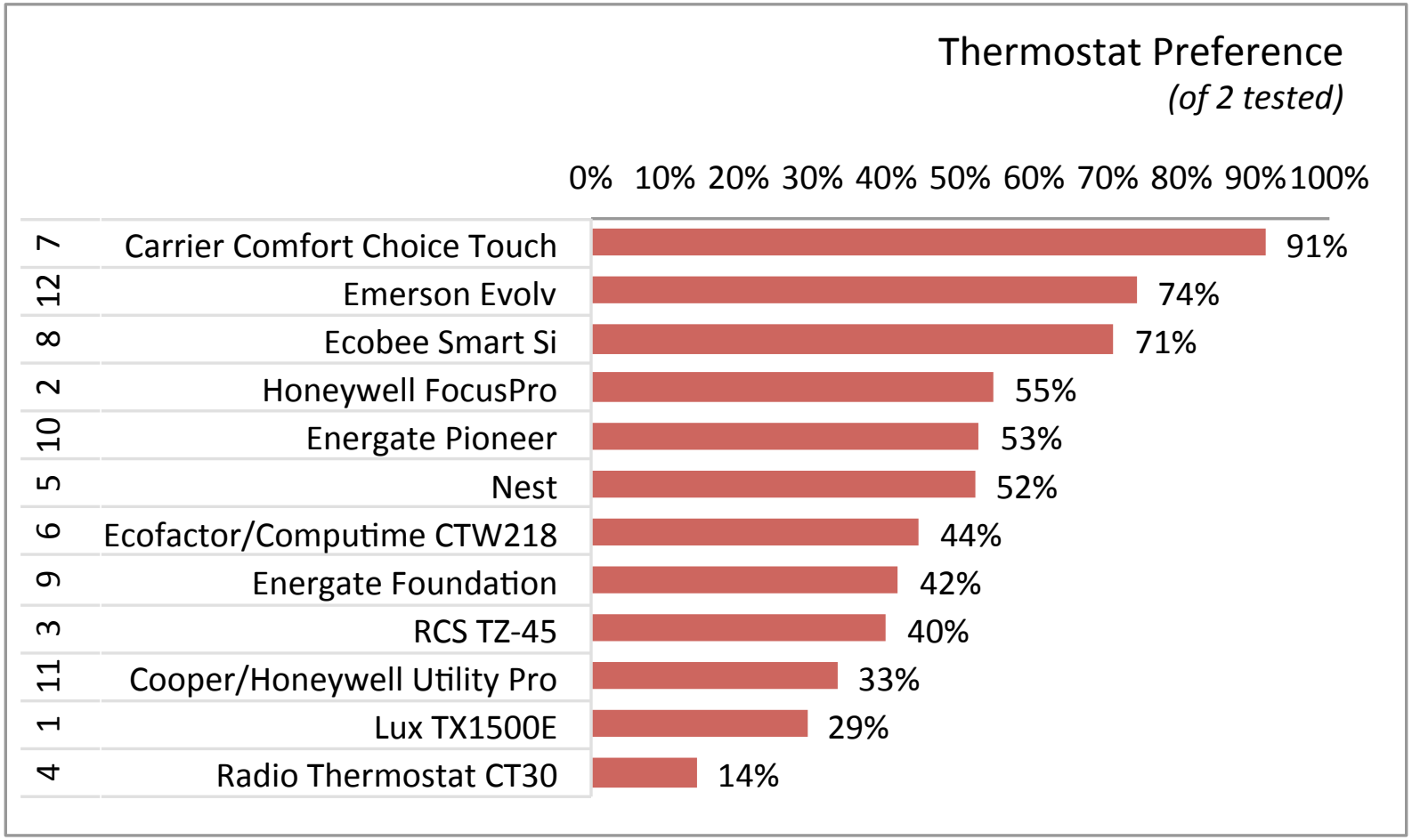
Results: Participant Preference



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Top Ranking Thermostats

Efficiency Ranking

1. **Carrier Comfort Choice Touch**
2. Honeywell FocusPro
3. Emerson Evolv
4. Radio Thermostat CT30 (3M-50)
5. Ecobee Smart Si

Preference Ranking

1. **Carrier Comfort Choice Touch**
2. Emerson Evolv
3. Ecobee Smart Si
4. Honeywell FocusPro
5. Energate Pioneer Z100

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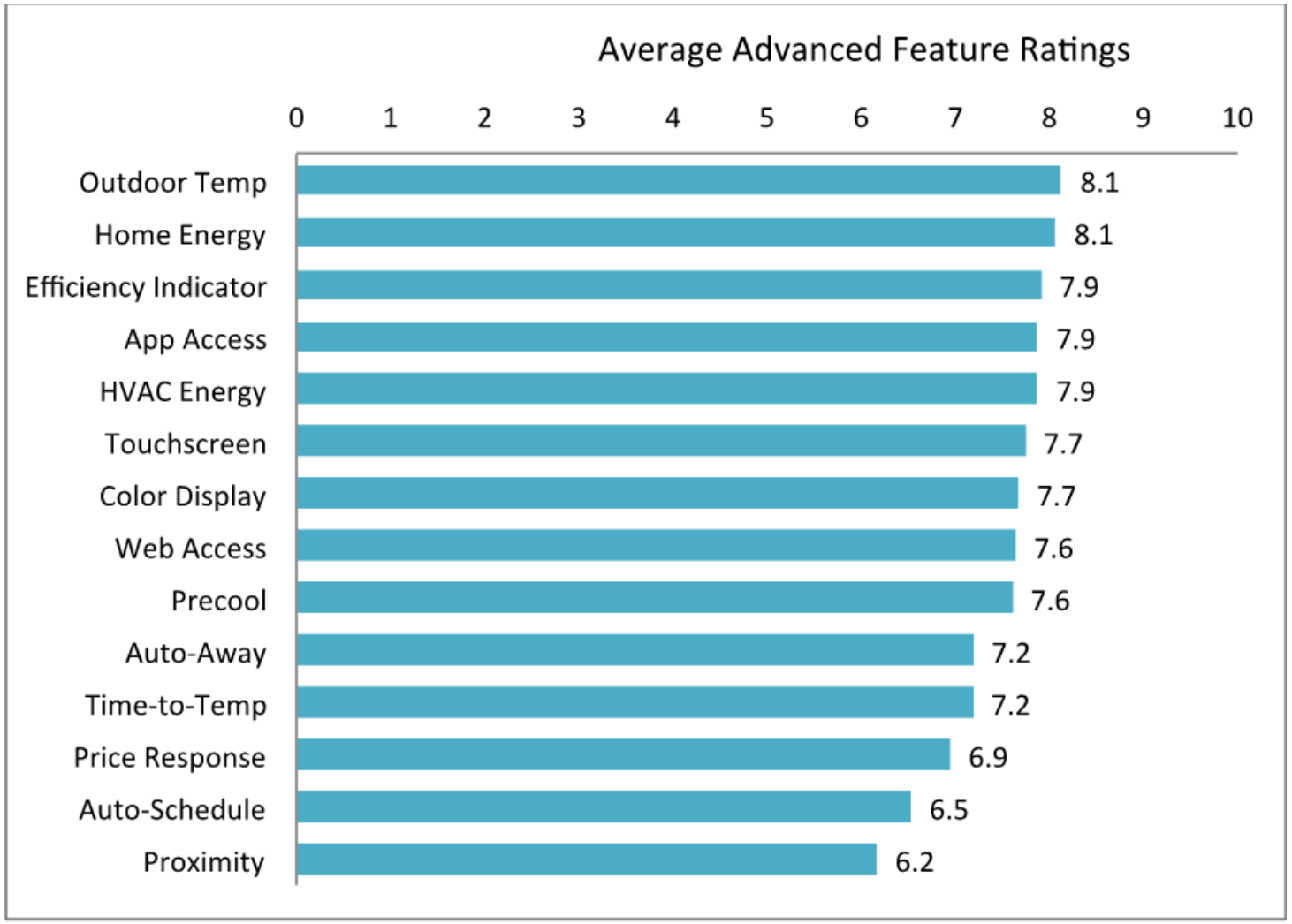
Perceived Usefulness of Potential Advanced Features



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Impacts of Standard Features

Smart Phone App	• No overall impact on final scores • Rated higher by younger users
Appearance	• Preferences related to appearance and style varied • Screen size was only appearance variable impacting overall scores
Number of Buttons	• The quantity alone doesn't appear to influence overall scores or stated preference
Feel and Sound	• **Overall Feel and Sound was the strongest predictor of preference**
Participant Characteristics	• Only age and home ownership were associated with significant impacts on scores
Screen	• Color display associated with higher preference scores • Touchscreen without color displays associated with lower scores • Screen size is less important than other features displayed on the screen

Other Features Suggested

Customize

- Ability to enlarge the font or zoom in
- Customer programmable screen color options
- Decorative housing skins
- Sound options – type, tone and volume

Integration

- Ability to integrate with other devices, e.g. whole house fans
- Ability to set a budget for heating/ cooling and have thermostat automatically adjust
- Display bill balance on thermostat

Automation

- Motion sensing to turn backlighting on and off automatically
- Wireless unit that can be placed anywhere in the home
- Voice control

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Recommended Procurement Guidelines

Display	• Greater than 4 sq. in. • Dynamic with more than 2 colors, crisp, good contrast • Backlighting with adjustable settings
Touchscreen	• Greater than 8 sq. in. • Sensitive and responsive • Text and symbols large and easy to read
Labeling and Input Mechanisms	• Meanings should be intuitive • Be of adequate size • Be soft but solid
Thermostat Unit	• Smaller than 40 sq. in. • Look clean, simple, modern and attractive • Smart phone app or online portal with consistent interface to unit
Sound and Lighting	• Volume for button noise, including off • Dimming for backlighting, including off • Confirmation of button press and task completed
Navigation	• Number of steps per task should be minimal • Basic instructions on or in device • Home, Back and Help buttons

U.S. Department of Energy Disclaimer

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Questions??

Contact:

http://www.herterenergy.com/pdfs/Publications/2014_Herter_CommunicatingThermostatUsability.pdf

Lupe Jimenez
916-732-5966
Lupe.Jimenez@smud.org

Karen Herter
916-397-0101
Karen@HerterEnergy.com

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Design Considerations

Shell

- Simple, contemporary overall look
- Thermostat should be big enough without being too obtrusive
- Basic instructions on the device
- Dial and switches of adequate size and minimal noise
- Buttons that feel good
- Buttons with multiple functions can create confusion for users

Display

- Adequate screen and font size
- Bright crisp display
- Good contrast on the display
- If you provide a touchscreen: color, sensitive to light touch, large enough
- Minimize the number of screens to navigate
- Backlighting that stays on long enough to complete tasks

Navigation

- Getting started should be easy and intuitive
- Navigation should be simple
- Clear labeling
- Provide confirmation when user inputs information or changes a setting (via sound, text or visual indication)
- Icons and symbols should be large enough to read and easy to interpret
- Have a “Home” button to bring users back to the home screen
- Have a “Help” button

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