

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460



OFFICE OF
AIR AND RADIATION

July 1, 2015

Dear ENERGY STAR® Connected Thermostat (CT) Stakeholder or other interested party,

In response to the March 2015 CT data call EPA has received a total of (6) data sets. One data set did not include run time data and is excluded from this cursory analysis. This letter discusses broad observations and initial conclusions associated with the submitted data. Submitted data is included in the attached "CT Data Call + Reporting Template.xls" file. This file includes (5) data sets as well as numerous charts.

Observations & Initial Conclusions

EPA asked several broad questions associated with the data call. These questions, as well as tested hypotheses are included herein, along with initial conclusions:

- Should regional heating and cooling baseline temperatures for conditioned spaces be established? (Hypothesis: Climate regions influence occupants' choice of temperatures and settings)
The hypothesis is supported. Findings from this limited data call indicate that warmer comfort temperatures are associated with warmer climate zones. The "Temps vs Climate" tab illustrates dependence of both thermostat target temperatures and inside temperatures on climate zone. In shoulder and core seasons for heating and cooling, comfort temperatures were warmer in the Hot Humid zone relative to the Cold zone. Average differences, across the 5 data sets ranged from 1.1°F (shoulder heating inside temp) to 3.6°F (shoulder cooling setpoint).
- Do outdoor temperatures in a given region reported by different service providers reasonably align with each other? (Hypothesis 1. Each provider's customer population faces similar distributions of outside temperatures, Hypothesis 2. Service providers use similar sources of outside temperature data)
Inconclusive – while the "Outdoor Temp Reporting" tab illustrates significant deviation of reported outside temperatures, this data call is comparing average temperatures in very large climate zones. A more valid comparison would be to compare reported outdoor temps across service providers in the same Zip code. Note that the initial field savings software module will perform a Zip Code based outdoor temperature lookup to ensure the same methodology is used for all service providers.
- Are there systematic differences between service providers in reported indoor temperatures in the same regions?
Yes, as illustrated in the "Cold Zone - Target vs Room Temp" and "HH Zone - Target vs Room Temp" tabs.
Hypothesis 1. During heating (cooling) season, indoor temperature will be similar to set points.
Hypothesis 2. During shoulder seasons, indoor temperatures will not be similar to set points.
Hypotheses 3. The annual average inside temperature will deviate from the average set point.
Hypotheses 4. Standard deviation will be lower for inside temperatures versus for set points.

The hypotheses are supported.

- Are there systematic differences between service providers in reported set temperatures in the same regions?

Yes, as illustrated in the “Cold Zone - Target vs Room Temp” and “HH Zone - Target vs Room Temp” tabs.

Hypothesis 1. Comfort temperatures vary between vendors. (90th/10th percentile of setpoint history)

Hypothesis 2. Lower heating comfort temperatures are used in colder climates. (90th percentile of setpoint history)

Hypothesis 3. Higher cooling comfort temperatures are used in warmer climates. (10th percentile of setpoint history)

The hypotheses are supported.

Hypothesis 4. Occupants manage set points differently during shoulder seasons.

The hypothesis is supported. On average, more energy efficient average setpoints are used in the shoulder seasons.

Hypothesis 5. Set points vary regionally and between vendors. (average setpoint)

The hypothesis is supported. Regionally, warmer setpoints are used for both heating and cooling in the Hot Humid zone relative to the Cold zone. Across datasets, average setpoints showed moderate variation.

- Are there significant differences in run time between service providers in the same region?

Yes

Hypothesis 1. Run time is similar in all regions, regardless of climate.

No, run time is climate zone dependent. The Hot Humid zone has significantly more annual cooling and significantly less annual heating run time relative to the Cold zone.

Hypothesis 2. Run time varies between vendors

Yes, as illustrated in the “Run Time Reporting” tab, there were dramatic difference in run time in the Cold Zone, core heating season in the with dataset 2 reporting seasonal heating run time over 2x greater than the next closest. In the HH Zone, core cooling season with dataset 2 reporting seasonal cooling run time nearly 3x greater than the next closest.

Hypothesis 3. Shoulder seasons represent less than 10% of total energy use.

The hypothesis is supported. Shoulder season run time as a percentage relative to core season run time ranges from less than 1% to 2.9%.

Hypothesis 4. Fan-only operation occurs less than 1% of the year.

No, reported fan only run times varied widely, ranging from less than 6% to over 300% relative to heating/cooling run times.

Additional Observations

1. **Cold Zone - Target vs Room Temp and HH Zone - Target vs Room Temp Tabs** – Inside and Target temps track closely in core heating and cooling seasons, but, as predicted, much greater differences occur in shoulder seasons.
2. **Temps vs Climate Tab**
 - a. Heating temps are higher in the HH zone relative to the Cold zone
 - b. Cooling temps are also higher in the HH zone relative to the Cold zone
3. **Outdoor Temp Reporting Tab** – Reported outdoor temps track well across datasets for heating, but deviate a bit for cooling. Results are inconclusive as datasets vary in size and geographic spread.
4. **Avg. Target Temp Reporting and Avg. Room Temp Reporting Tabs** – there appear to be trends/patterns specific to different datasets
5. **Run Time Reporting Tab**
 - a. Dramatic difference in run time in the core heating season in the Cold Zone with dataset 2 reporting seasonal heating run time over 2x greater than the next closest.
 - b. Dramatic difference in run time in the core cooling season in the HH Zone with dataset 2 reporting seasonal cooling run time nearly 3x greater than the next closest.
6. **Run Time & ΔT Tab**

- a. For heating a positive ΔT is to be expected. However, ΔT is also quite often positive during cooling seasons (positive ΔT occurs when the avg inside temp is higher than avg outdoor temp) – it will be interesting to focus on the effect of only using negative (cooling season) ΔT s in modeling the home’s thermal characteristics. In the cold zone, ΔT was positive even in the core cooling season.

Stakeholder Feedback

EPA recognizes the high level of building science and energy analytics expertise within CT stakeholders and encourages stakeholders to provide additional analysis and recommendations applicable to modeling of deployed CT energy savings. In lieu of a formal commenting period, EPA encourages stakeholders to:

1. Review the CT Data Call + Reporting Template as well as the above EPA observations and initial conclusions.
2. Provide feedback on appropriate thermal modeling of cooling season performance in regions where average inside temperatures are often higher than outside temperatures during the cooling season.
3. Contribute observations, findings and conclusions via participation in the bi-weekly conference calls and/or via phone calls or email with the ENERGY STAR CT team.

If you have questions, contact Abigail Daken at EPA, daken.abigail@epa.gov, 202-343-9875, or Doug Frazee at ICF International at douglas.frazee@icfi.com, 443-333-9267. We look forward to your engagement.

Sincerely,



Abigail Daken
ENERGY STAR HVAC Product Manager