EPA ENERGY STAR Connected Thermostats

Stakeholder working meeting

Connected Thermostat Field Savings Metric

8/27/2015

Agenda

- Introduction – anyone new joining the call?
- General update on next steps and approach
- Software module alpha release
- How to choose data to include in the calculation?
- Looking forward to additional topics

Attendees

- Abigail Daken, EPA
- Doug Frazee, ICF International on behalf of EPA
- Dan Cronin, ICF International on behalf of EPA
- Matt Gee, Open EE on behalf of ICF and EPA
- Alan Meier, Lawrence Berkeley National Laboratories
- Ethan Goldman, VEIC
- Ed Pike, Energy Solutions, on behalf of CA IOUs
- Michael Blasnik, Nest Labs
- Brent Huchuck, Ecobee
- Ford Garberson, Ecofactor
- Chis ???, Ingersoll-Rand (Trane)

General update on approach and immediate work items

- In the last couple calls, and in comments, there were several issues brought up with the hybrid run time metric we are currently pursuing
  - Baseline choice means solutions which encourage more EE temps all the time are not rewarded
  - Many homes may not fit the model well, or have nonsensical results (e.g. negative intercept on the run time-ΔT plot)
- While these are important issues, EPA feels, and many stakeholders we spoke to agree, that we haven't yet gone far enough on the current metric to really know
- EPA expects to continue on this path at least somewhat further, continuing to get modules operational and discuss specific issues

Software Modules Alpha Release

- Help now available to get the modules working
- In addition, modifications and updates previously identified will now be acted on
  - Input file format updates
  - Better documentation and sample files
  - Algorithm modification to eliminate linear fit for HDD/CDD method
- Complete list of known issues and improvements will be on GitHub, along with milestones
- Stakeholders are encouraged to add additional issues there; if that doesn't work, email Doug Frazee and/or Matt Golden

Software modules discussion

- Several vendors have been able run the code
- Concerns about scalability? Anyone run into issues that would argue it's a problem?
  - Underlying OEE code may be an issue
- Are stakeholders intending to use an environment that can use parallelization to speed up code?
  - Yes, in production
- Sample outputs were identical for several different algorithms for several homes
- Systematic bias on 1 hour vs half hour minimum run time cutoff
- To be continued on next call

Which data to include?

- Start from a straw man assumption that we would like data from all homes participating in the service
  - Some homes will have data that is invalid for various reasons
  - In addition, the sheer amount of data may be too high in some cases, and sampling will be required
- How do we build representative data sets given these issues?

What proportion of homes are we excluding, anyway?

- Multistage or variable capacity equipment, dual fuel heating systems
- Need to understand if there is a useful fit for homes with:
  - Multiple t'stats, zoned systems
  - Infrequent occupancy
  - Missing data, and how much
  - Heat pumps with back up heat
- What proportion of homes do the above categories cover?
- What about those with just a poor fit?
- Reason to think it might be different for heating than for cooling? For instance, wood stoves.

Elements of “representative”

- Large enough to average over changes in household make up or occupancy patterns
- Variety of climates/locations
- Represents user base for the product (assuming nationally representative of population not possible)
- Others?

Discussion of building representative samples

- What proportion of homes are we excluding?
- Multiple thermostat homes:
  - One vendor: may be more than 50% in some areas with CTs
  - Can see some evidence of homes with additional non connected stats
  - Another vendor: more than 1/3 have more than one of our ‘stats
  - 2 stage cooling is below 5% and 2 stage furnaces is below 5%
  - Assertion that homes above 2,500 sq ft have rising fraction of multiple systems; above 3,000 sq ft typical (10% - 80% range over 1500 – 3000+ sq ft range)
  - Cold climate zone has fewer multi ‘stat homes
  - Additions also may have separate systems and separate ‘stats
  - Another vendor: our percentages seem to be lower, perhaps because one of our products has remote sensors

Discussion of building representative samples

- For multiple sensors for a single stat controlling a single HVAC system, what should be used for indoor temperature data?
  - Discussion best had with individual vendors first
- What happens in multiple CT homes? Do they have good data? Do we need to exclude them?
  - One vendor: as long as we control all the ‘stats, we can use the algorithm – over large samples, tends to average out
  - Typical for lower floor to carry heating load and upper to carry cooling load, but perhaps it all averages out if all floors are CTs from one vendor.
  - Another vendor: need to crunch data
  - Another vendor: haven’t done a systematic study, but likely to get a lot of funky results

Discussion of building representative samples

- Interesting separate point – homes with poor fits seem to systematically have a shallower slope and therefore less savings. Noisy x values will statistically lead to a shallower slope because slope of random noise is zero.
- Threshold or criteria for how good the fit needs to be may end up with a huge bias toward extreme temps
  - 10% or less error estimated that more than 80% of cold climate homes have good fits in heating, but only about a third have good fits in cooling. Opposite for hot humid climate.
  - Minimum run time threshold also biases against oversized systems. Used data for all year, implementing 1 hour run time minimum, and tried half hour minimum.

Discussion of building representative samples

- SDH like measure may mean that we can worry a lot less about different kinds of systems
- More that run time information is in there, the more useful it is for EEPS
- Vendor: Not clear that temp only metric actually does a worse job of predicting the energy savings, though the reason it's predicts well is less clear.
- For a sample of several hundred homes, expected % savings based on SDH like metric, looking at reduction in the average delta T, assuming the same temperature float for all homes. Matched results from regression models, and matched best for those that had the best fit

Discussion of building representative samples

- Separate modeling of sensitivity to temperature from modeling of temperature choices
  - For each home, use the actual temperature choices from it's annual data
  - However, for the model, use a model averaged over a large number of homes. Derive run time reduction based on shared model and actual temperatures.
- Poor fits may in fact be a result of having a low sensitivity to temperature changes, so applying that same sensitivity to those with poor fits may overestimate savings.
- Not likely to effect results that much, but may handle messy cases better.

Discussion of building representative samples

- Missing data and infrequent occupancy?
  - Do different vendors have different #s of homes with infrequency occupancy?
  - Depending on algorithm, may over- or under-predict savings
  - Can we eliminate homes with infrequent occupancy?
  - Is there a need to? If vendors are in fact saving energy in unoccupied homes shouldn't that be included? Should we have a different version of the algorithm during unoccupied periods? Personalized baselines not likely to work.
- How common are homes with infrequent occupancy? (e.g. less than 4 weeks total per year)
  - One vendor: single digit percentages (1-5%?)
  - No data, but guessing small percentages: 10% of 'stats in away mode in a given day, so a small fraction of that would be vacation

Looking forward to additional topics

- Several stakeholders have said that the 10th and 90th percentile temperatures do not clearly represent a comfort preference for their users
- What other suggestions are there for detecting comfort preferences from history of set points and indoor temperatures?
  - Use average indoor temp as a baseline (guarantees savings are zero)
- To be discussed further on upcoming calls
- Also: more on regional baselines
- Turning off algorithms would work for some vendors, but not for all.

Contact Information

Web site for these notes and all public discussion/comments:
http://www.energystar.gov/products/spec/connected_thermostats_specification_v1_0_pd

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