ENERGY STAR Connected Thermostats

Stakeholder Working Meeting
Field Savings Metric

May 26, 2017

Attendees

Abigail Daken, EPA
Dan Cronin, EPA
Dan Baldewicz, ICF International, for EPA
Alan Meier, LBNL
Marco Pritoni, LBNL
Inês Azevedo, Carnegie Mellon
Brock Glasgo, Carnegie Mellon
Ethan Goldman, VEIC
Nick Lange, VEIC
Michael Blasnik, Nest Labs
Frank David, Carrier
Jing Li, Carrier
Brent Huchuck, Ecobee
Nkechi Ogbue, Ecobee
Wade Ferkey, AprilAire
Michael Siemann, Whisker Labs
Laurie Sobczak, Comverge
Alex Bosenberg, NEMA

Ed Pike, Energy Solutions, for CA IOUs
Ulysses Grundler, Ecofactor
Karl Muntchnik, IRCO (Trane)
Roy Crawford, IRCO (Trane)
Kurt Mease, Lux Products
John Sartain, Emerson
Charles Kim, SoCalEdison
Henry Liu, PG&E
Jia Huang, PG&E
Michael Lubliner – Washington State University
Essie Snell, eSource
Theresa Weston, DuPont
Michael Fournier, Hydro Quebec
Brian Rigg, JCI
Shawn Hern, JCI
Theresa Gillette, JCI
Diane Jakobs, Rheem
Phillip Kelsven, BPA

Agenda

- A first look at certification data
  - Heating and cooling savings
  - Regional savings results
  - Regional baseline results
  - RHU problems
- Tackling variable capacity systems

Certification data: national savings

		Heating				cooling		
	spec	Apple	Grape	Pear	spec	Apple	Grape	Pear
mean		12.25	15.43	11.15		15.84	18.12	14.87
lower 95 bound	8	11.79	15.05	10.72	10	15.35	17.66	14.33
Q20	4	7.78	11.64	7.02	5	10.20	12.96	8.86

- The product with the highest metric score may not give the highest metered energy savings
- Using the per-home baseline as specified
- Results indicate healthy margins

Certification Data: Regional Savings

	Heating (L95)			Cooling (L95)		
	Apple	Grape	Pear	Apple	Grape	Pear
Very cold/ cold	10.01	14.84	8.89	15.33	22.03	13.12
Mixed humid	11.54	13.29	10.28	14.47	18.51	12.86
Mixed dry/ hot dry	18.32	15.86	18.38	15.77	12.80	15.15
Hot humid	15.20	17.20	14.88	14.96	16.82	14.56
Marine	19.14	21.61	16.67	19.02	12.31	18.88

- Using the per-home baseline as specified
- No individual region for any product is below the specified savings

Certification data: national savings with regional baseline

	Heating			cooling		
	Apple	Grape	Pear	Apple	Grape	Pear
mean	-0.12	-1.28	-1.01	4.70	14.62	3.31
lower 95 bound	-1.37	-2.73	-2.14	3.31	13.33	1.81
Q20	-12.69	-14.23	-6.33	-9.34	3.03	-10.55

- Is there is something messed up in the code?
- Would be interesting to see what results are with 72F.

Baseline temps	Cold/ very cold	Mixed humid	Mixed Dry/ Hot Dry	Hot humid	marine
Heating	68	69	69	70	67
cooling	73	73	75	75	N/A*

* RECS did not have enough data to draw a conclusion

discussion

- Clarification: difference between L95 and Q20?
  - L95 = lower 95 confidence interval of the mean
  - Q20 = 20th percentile of the results; 80% of results were above this point
- Regional baseline temps are much lower than the average temperatures from the sample of homes – so the disconnect is likely the temperatures themselves, not the code
- ACEEE 1990 summer study: mean separation between measured and RECS data 1-4F, with less energy conserving indoor temperatures measured in both heating and cooling season
- Ed Vine, Energy 1989: reported settings 2F cooler than actual temps in heating season (e.g. reported setting 70F, measured temp 72F)
  - Droop from mechanical thermostats? Nope, wrong direction.
- Error in thermostat temperature reading?
  - Would require a systematic bias in thermostat readings
  - Also very reasonable to think that people report their aspirations

discussion

- Since we're analysis is hourly, do we need to use a daily average baseline or can we use an hourly average baseline and capture something like a baseline setback behavior
  - Using occupied temp from RECS would be more comparable to what we are now doing
  - Would use data clustering to compare continuously-occupied homes to baseline data that makes sense for that, and homes with periods of absence to a baseline schedule appropriate for that
- Even if RECS reported temps were accurate, we still have the difference between set temperatures (as reported in RECS) and indoor temperatures (as used in the software)
  - When you set back at night in winter, it takes many hours to cool down to the set point (if it even gets there), and takes much less time to heat back up.
  - Solar and internal gains in the middle of the day might also push the temperature above the set point in the middle of the day.
- RECS data also doesn't distinguish core and shoulder seasons.

discussion

- Question to start on with the certification data:
  - Are there differences in regional average comfort temps between vendors?
  - Construct what we think typical homes' average indoor temperatures (and comfort temps) are for homes with smart thermostats
  - Also providing heating and cooling set points in the certification data input file, so the code could fairly easily be modified to output regional average schedule and hourly indoor temperature
- Can we take into account how zip-code level factors (e.g. income) for CT users bias the CT data, to partly account for the non-representativeness of CT users
  - Sub-problem: are there differences between vendors in these factors?
  - In some areas, utility programs may lead to a sample of CT users that is more representative of the general population

discussion

- General question about self-selection bias
  - What would we like? Representative results for the general population, ideally.
  - Over time, the population of CT users will look more and more like the general population
  - Homes with unreliable broadband (small percentage) will never be part of our sample

Certification data: RHU

- Only one vendor had non-zero values
- Dan Baldewicz at ICF will work with vendors to find the source of the problem and fix for periodic resubmission
- Since one vendor has sensible numbers, look first to input data formatting issues
- Will report back during June meeting

discussion

- Emergency heat is used only in emergency?
  - Not necessarily, since there are non-emergency conditions that warrant avoiding use of compressor
  - Thermostats don't put systems into emergency heat use themselves – they have to be set into it manually
  - Disagreement between vendors on this point
- Auxiliary heat (running in addition to compressor) is typical
- Does a defrost cycle show up in the cycle as emergency heat (or as aux heat)? No - equipment itself calls for defrost, not the thermostat
- Do all connected thermostat vendors have aux heat lock out (based on outdoor temperature) capability built into the thermostat? (This is often a code requirement.)
- Sizing matters to aux heat use. Modern sizing guidelines may lead to less use of aux heating in heating-dominated climates. (Assuming installers are following sizing guidelines).
  - For existing homes, likely oversized, but may be less true for new homes

discussion

- Error in analysis code – missing value or zero when there is no data
  - In hot humid, if there are no data where it is between 0 and 5, there should be no heat pumps. Instead, it appears that in that bin there are however many heat pumps there are, irregardless of whether they ever experienced that temperature. Then all those zeros are averaged into the total.
  - If the outdoor temp was never experienced, the heat pump shouldn't be counted in that bin, and the run time should be irrelevant instead of having zero run time averaged in.
- This will be addressed promptly

Tackling variable capacity systems

- Between the last few months of discussion, seems that mini-splits and multi-splits, which are inherently zoned, may need a different treatment than centrally-ducted staged and variable capacity systems.
- Will start with centrally ducted and see how far we can get.
- Meeting in planning for early June – likely settle on a date/time next Wednesday or so.

discussion

- No disagreement expressed.
- Hard to separate equipment savings from thermostat savings for mini-splits and multi-splits
  - But an important growth area in the market, so don't give up
- How common are centrally ducted variable capacity systems? Are they even in the market?
  - the question we are examining includes 2 and 3 stage systems
  - BPA: 30% of measure claims are inverter driven for centrally ducted systems

Contacts for various work streams

- **Regional temperature baselines**:
  Brock Glasgo, 513-519-1008, bglasgo@Andrew.cmu.edu
- **Multi thermostat homes/zoning**:
  Alan Meier, 510-486-4740, akmeier@lbl.gov
  Dan Baldewicz, 518-452-6426, dan.baldewicz@icf.com
- **Staged/variable capacity systems:**
  Abi Daken, 202-343-9375, daken.abigail@epa.gov
- **Incomplete data:**
  Dan Baldewicz, 518-452-6426, dan.baldewicz@icf.com

- Everything else, including the specification:
  Abi Daken, 202-343-9375, daken.abigail@epa.gov or
  Dan Baldewicz, 518-452-6426, dan.baldewicz@icf.com