



ENERGY STAR Connected Thermostats

Stakeholder Working Meeting Field Savings Metric

January 29, 2016



Agenda

- Data call
 - status
 - Identified bugs & fixes
 - Stakeholder feedback
 - Open issues/bugs?
- Treatment of non-contiguous data
 - Stakeholder input on data validity rules, e.g.
 - 2-3 hour gaps – use interpolation to “fill in the gaps”?
 - Longer gaps – remove entire day(s) from analysis?
 - How much missing data is too much?
- Update on savings



Attendees

Abigail Daken, EPA

Doug Frazee, ICF International, for EPA

Jennifer Kulp, ICF International, for EPA

Dan Baldewicz, ICF International, for EPA

Alan Meier, Lawrence Berkeley National Laboratories

Ethan Goldman, VEIC

Nick Lange, VEIC

Michael Blasnik, Nest Labs

Dave Cassano, Nest Labs

Raj Shah, Carrier

Paul Kinningham, Carrier

Phil Ngo, Impact Labs

Brent Huchuck, Ecobee

Wade Ferkey, AprilAire

Jack Callahan, BPA

Michael Siemann, Weatherbug Home

Wendell Miyaji, Comverge

Laurie Sobczak, Comverge

Alex Bosenberg, NEMA

Matt Golden, Open EE

Ed Pike, Energy Solutions, for CA IOUs

Ford Garberson, Ecofactor

Ram Soma, Ecofactor

Chris Smith, IRCO (Trane)

Roy Crawford, IRCO (Trane)

Kurt Mease, Lux Products

John Sartain, Emerson



Data request

- Still two data sets, still expect at least one more
- Identified bugs and fixes in V 2.15
 - CDD/HDD may not calculate on a thermostat if data is missing on Interior Temperature, and/or Heating/Cooling set points.
 - Sign Error bug fixed in one of the CDD methods for cooling season,
- Open bugs and issues
 - Incorporate data validity rules
 - Incorporate interpolation for missing data of up to x-hours?
 - Enable output of regression models & outside temperatures
- Treatment of non-contiguous data: Output a single set of savings data for cooling and a single set of savings data for heating, independent of the reporting interval?



Data request – data validity

- Current data validity rules deal with missing run time data and outdoor temperature, but indoor temperature and set temperatures for heating and cooling
- For short periods of missing data, we can interpolate.
 - Temperature data is more sensible to interpolate because it is more predictable than run time data.
 - Does it make sense to interpolate indoor temps and set points over a period of hours – how many hours?
 - Set points that don't change are easy to interpolate
 - Sometimes run time data are present but temps are not – important because you have to use a complete data set.
 - Comfortable filling in a couple of hours



Data request – data validity

- For both run time and temperatures, could fill in missing run time and temperature data with data from previous and following days
 - Somewhat problematic because we are likely to get a weekend
- Why would we ever have some data from the home but not all of it? How common is it?
- Usually will be both missing if either are – general agreement
 - Depending on how run time is submitted, the report after a gap could include the time accumulated from the previous period



Data request – data validity

- If no run time data is reported, could it be recorded as a 0 even if it isn't?
 - Loss of communication doesn't lose run time data, as it is accumulated outside the thermostat
- For some vendors, total accumulated run time is kept; for others not, or are not sure.
- (one vendor) For significant time gaps (greater than a few hours), if data is missing, would show as a blank space in an hourly data plot



Data request – data validity

- Is missing data the rule rather than the exception? What is the pattern?
 - Many thermostats have high connectivity, so we would normally throw out those with more than a few hours dropped out
 - It's not uncommon to be missing 5 minute data, but not enough to be a huge concern
 - Some houses less likely to stay connected than others, but generally good
 - Connectivity is the norm – more than 2 hours missing usually means a connectivity problem in the home and problem can be expected to recur



Data request – data validity

- Three uses of data
 - Building the model of the home, throwing out a day or two isn't a problem, but we would prefer to have full run time data for each day that is included – short gaps (1 or 2 hours) in temperature we can interpolate over
 - For comparison of annual run time, real world vs. modelled baseline condition, we need to make sure that any period missing real world accumulated data is also skipped in the baseline condition
 - For resistance heat utilization, accumulated run time reported in the wrong hour may be binned to the wrong outdoor temperature – how significant is that? More so for longer gaps. Further discussion tabled.



Data request – data validity

- How many days can be missing from the correlation and we still keep the thermostat? Or do we just rely on goodness of fit statistics?
 - Problematic homes have lots of missing data – would be better to exclude them as they will be hard to analyze well
 - Opinions on excluding homes with more than 10 days unusable?
 - May not be that simple – common hour missing spread over a season is different than a large block missing in the core season, even if the total missing time is the same (one vendor agrees)
 - Missing several days in a row throw out, missing up to 10% keep spread throughout season, keep?
 - Could also judge whether days that are missing are very cold/very hot, whether they are due to power outage, etc.



Noncontiguous data – discussion

- January through December data – should it return one heating savings measure from all the data, or should it not?
 - (one vendor) As the algorithms change, may not be the same thermostat for the two non-contiguous heating periods
 - (another) Utility billing analysis typically does this, so why is it not good enough for us?
 - (EEPS) One winter should be included, even if it spans calendar years. Can't be done over a part of a season, but it does need to cover the full range of seasonal temps
 - EPA will want to have data every six months no matter what, and will want to have full seasons in each



Savings back of the envelope calculation results - updated

| | heating savings | | | | | cooling savings | | | | |
|--|-----------------|-------------|-------------|-------------|-------------|-----------------|-------------|-------------|-------------|----------|
| | VCC | MH | MDHD | HH | MAR | VCC | MH | MDHD | HH | MAR |
| New best estimate of season savings | 2.8% | 4.1% | 5.5% | 5.2% | 4.8% | 1.3% | 1.7% | 2.3% | 1.8% | Q |
| Savings per degree set back or set up | 4% | 6% | 6% | 9% | 5% | 9% | 10% | 8% | 10% | 7% |

In these numbers, float is accounted for in the savings per degree set up or set back



Comments on the back of the envelope calculation

- Utilities may have studies of the behavior of thermostat behavior in their service territory - can it be compared in a few places to see how it holds up?
 - There really is a shortage of good data on thermostat behavior without connected thermostats. In the future, we will eventually have good data.
 - Like the approach of figuring out the realistic baseline separately
- The delta T is only part of what determines savings – the actual run time also affects how much you save. Ultimately, you want the therm or kWh savings. A small % savings in a very cold climate could be significant energy savings.
 - EPA comments this is true for payback as well.



Next steps

- Re-submit some data once EPA asks for it, software is stable
- Draft 3 February or March, along with second draft Method to Demonstrate Savings
- Draft Final April or May
- Finalize in May in June, available for immediate certification of products



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