ENERGY STAR Connected Thermostats

Stakeholder Working Meeting
Field Savings Metric

February 17, 2017

Attendees

Abigail Daken, EPA
Dan Cronin, EPA
Doug Frazee, ICF International, for 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
McGee Young, Impact Labs
Brent Huchuck, Ecobee
Nkechi Ogbue, Ecobee
Wade Ferkey, AprilAire
Michael Siemann, Whisker Labs
Wendell Miyaji, Comverge
Laurie Sobczak, Comverge
Alex Bosenberg, NEMA
Ed Pike, Energy Solutions, for CA IOUs
Ford Garberson, Ecofactor
Ulysses Grundler, Ecofactor
Ram Soma, 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
Dave Piecuch – UL
Michael Chiugu– UL
Essie Snell, eSource
Theresa Weston, DuPont
Michael Fournier, Hydro Quebec

Agenda

- Recap of Current Software and Metrics
- Priorities for 2017
  - Outline of known possible topics
  - Poll on priorities
  - Stakeholder discussion

Recap: ENERGY STAR Connected Thermostats

- Connected Thermostats Version 1.0 is available for certification:
  - Eligibility Criteria for Version 1.0.
  - Method to Demonstrate Field Savings.
  - Random Number Seeds for Savings Method.

Recap: Software

- Current Software is Thermostat Module V1.1.1:
  - Packages on PyPI: https://pypi.python.org/pypi/thermostat/1.1.1
    - Pip install thermostat
  - Source Code on GitHub: https://github.com/EPAENERGYSTAR/epathermostat
  - Documentation on ReadTheDocs: http://epathermostat.readthedocs.io/en/latest/

Recap: Metrics

- Hourly HTD method
  - Savings estimate based on run-time reduction
- 90/10 constant comfort temperature baseline
- Regional Grouping via EIA Zones
  - Very Cold-Cold, Mixed Humid, Hot Humid, Mixed Dry-Hot Dry, Marine

Possible work moving forward

- Known metric improvements that we have some kind of a path in mind to address
  - Weather correction
  - Regional baseline of daily average indoor temperature
  - Using data from installations with stepped or variable capacity HVAC
- Known metric improvements that we have no idea how to address; will not show up with a temperature baseline?
  - Savings from zoning
  - Savings from night flushing, shading, and other behaviors
- Spec improvements separate from metric improvements
  - Inclusion of line voltage thermostats
  - Determining if electric resistance backup heat control is a differentiator, and addressing it

Other Items for Consideration

- Homes with multiple thermostats – is this even a problem? Do we need to treat this case differently? What about multiple temperature sensors? Does it matter how many zones of heating/cooling equipment there are?
- Derating/calibration of baseline due to known set back/set up activity in actual homes. Comparison to other data?
  - Same thing different way: try to score homes without connected thermostats using the same metric.
  - BTW, RBSA is running again, at least 100 homes with T_{indoor}
  - Similar approach for some of southern CA
- Variable capacity: may be necessary to come up with a completely different approach; opportunity for new data
  - Discussion of problem of thermostat having data on the energy use by the equipment
  - Complication: varying efficiency at various capacity, makes it hard to know how energy use would be different for a different temperature-based demand
  - How do we account for variable capacity equipment

Other Items for Consideration

- Possibly characterize savings from cooling more when it's cooler out?
- Radical change: Go back to saving degree hours or something similar, to avoid complication of run time for various kinds of equipment
  - Can capture savings from setback/up and from more efficient comfort temperature
  - For some homes with heat pumps and variable capacity equipment, there may be more savings from no set back/up. How big is this effect?
- Meta-question: which effects are most important to address – are there small studies out there to guide us.
- Also step back: how accurate do we need to be for this standard? What inequity, from a policy perspective, is the inaccuracy driving.
- Weighted sum for stage 1 and stage 2, check to see if it is different from results from the same CT product in the same area using fixed capacity equipment
- Verifying metric scores relate to metered energy savings

Other Items for Consideration

- From spec
  - Device standby power (spec)
  - Accuracy of static temperature accuracy measurement (spec)
  - Refine procedures to handle missing data and/or encourage data completeness (metric, largely)
  - 3rd party verification of metric scores (separate discussion)
  - Running software on 3rd party server (separate discussion)
- Line voltage thermostats – how would the metric react? (both zoned and variable capacity)
- Go back and look at savings degree hour.
- What about looking at outdoor humidity as well as temperature as a driver of a need for cooling?
  - Monsoon month in one part of Arizona in summer could give us some insight?
  - In a given climate, excellent correlation between outdoor temp and outdoor enthalpy, so may not be a big influence in practice

Other Items for Consideration

- Where is the greatest uncertainty in vendor submission of metric?
  - Heat pumps: score well on metric but increase energy use
  - Multi-thermostat homes: relationship a lot noisier yields systematic bias toward lower savings because of shallower slopes
  - Mild climates: is this really an accurate characterization for this? We aren't capturing savings in shoulder seasons at all. Larger behavioral influence, that might not be captured by metric. Humidity control also presents opportunity for savings. Clear that most energy use is in more severe climates and core seasons, but less clear that the opportunity for savings is greatest there
- Could do some synthetic studies (simulation) to understand how important weather correction is.
  - Note that weather conditions affect set points – could be that the behavioral response to different weather masks or overwhelms the affect of weather itself.

Weather Normalization

- Background: Heating and Cooling savings metric scores are expected to vary somewhat depending on how hot or cold the year is, limiting the usefulness of comparing year to year results

- Weather Normalization possibilities
  - Include more than one year in analysis
  - Normalize to TMY or in some other way
  - Smoothing methods

- Time scale: test whenever ready, incorporate into metric for next spec revision (2020?)

- Resources needed: programming time, normalization expertise, participation of those with data

Regional Baselines

- Background: Current model uses inside temperatures to estimate desired heating and cooling comfort temperatures based on the 90th and 10th percentiles.
  - Only rewards savings based on achieved setback/setup
  - Worse, score is lower if CT works to moderate “comfort” temperatures.
  - Baseline independent of home addresses this problem, even an arbitrary one
  - Regional baselines are attractive because they can correct for vendor-to-vendor differences in customer base (which is partly why the per-home baseline was chosen)
  - Average indoor temperatures suspected of varying regionally because of climate, culture, demographics, etc.
- Time scale: 2 year project to develop baselines, test for 1 year, incorporate into metric for next spec revision (2020?)
- Resources needed: research Carnegie Mellon (Ines and Brock)

Additional Equipment Types

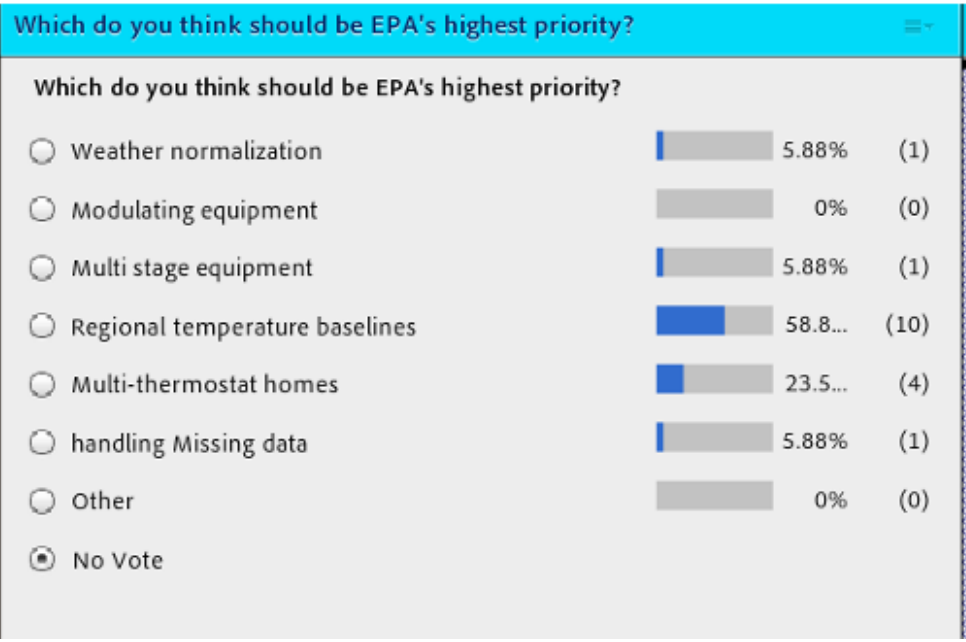
- Background: Current model estimates a linear relationship between temperature demand and run time, using run time as a proxy for energy use
  - Valid for fixed capacity equipment only, so sample of installations only uses those controlling fixed capacity equipment
  - Limits ability of some thermostats, designed specifically for variable capacity equipment, to participate
- Potential solution: build relationship between temperature demand and energy use instead – but is it a linear relationship?
- Time scale: Can be incorporated into metric software when ready
- Resources needed: equipment manufacturer engagement, programming

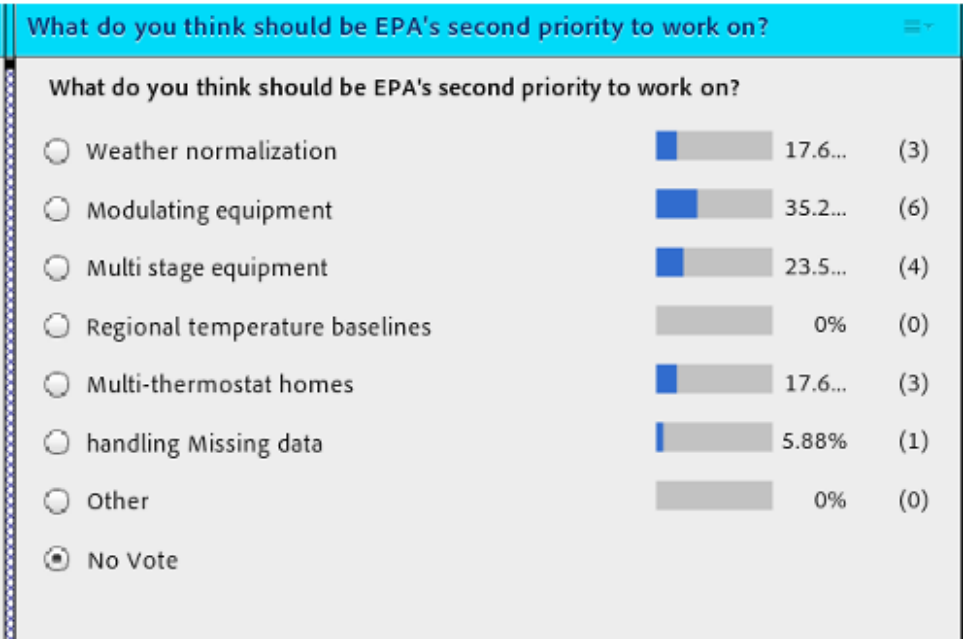
Polls: priorities

- Take a moment to think which of these six topics (or what other metrics topic) you think are most important to work on
  - Polls: first and second priorities
  - Weather normalization
  - Multi-thermostat homes
  - Modulating equipment
  - Staged equipment
  - Regional temperature baseline
  - Treatment of missing data

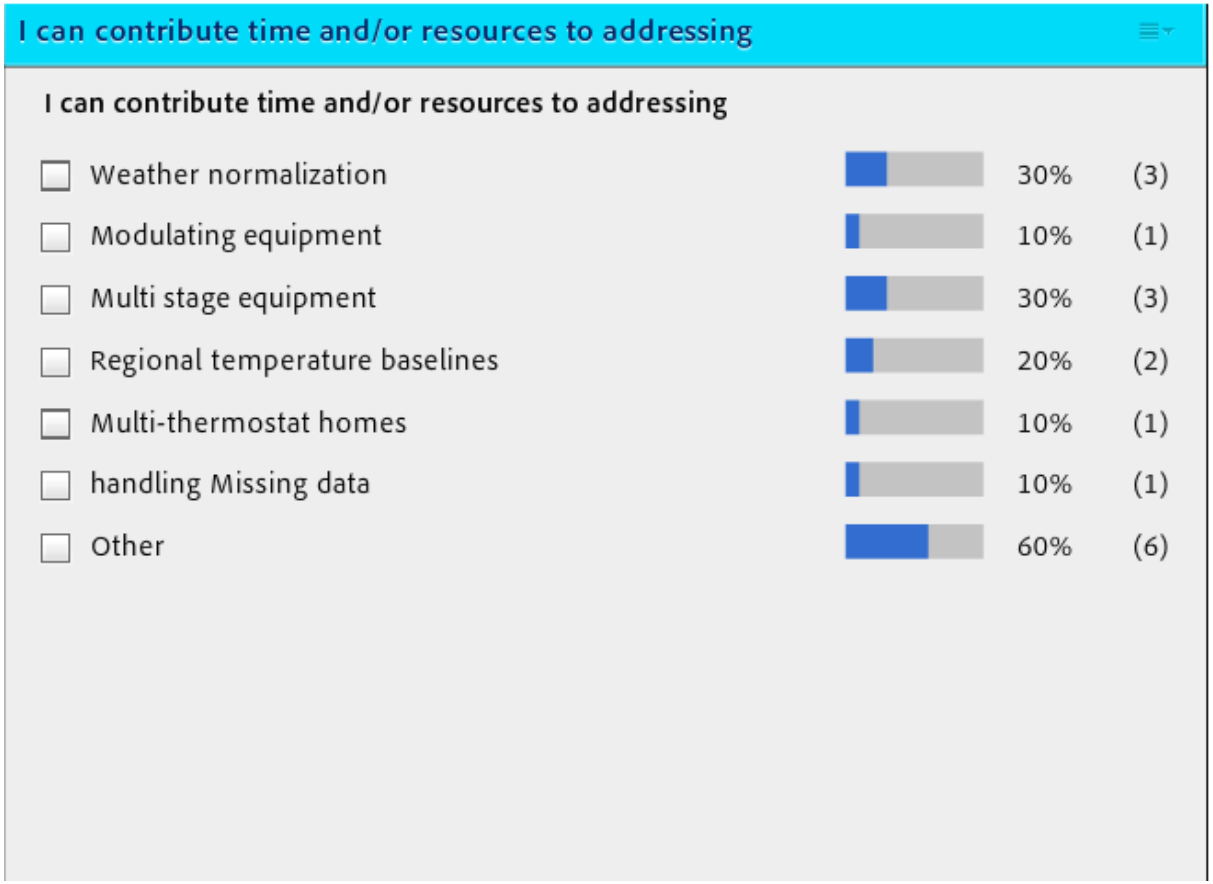
- Also take a moment to think about which of these three topics (or what other metrics topic) you and/or your organization can contribute time, data, and/or expertise to in 2017
  - Poll: I can help!

Poll: Priority Results





Poll: Stakeholder Support (Time and Resources)



Open discussion

- Data for regional baselines?
  - NREL nationwide temperature logger study (Ethan will track down the researcher)
  - What can we do with data from connected thermostats themselves? It's great data, but not from the sample we want to understand
  - There is always RECS, for all its flaws
  - Utility collected data (Seattle, RBSA, Pecan Street, California RAS?, PG+E may have tstat setpoints from residential survey)
- ASHRAE 90.2: Residential performance + talking to RESNET folks
  - How would the designation eventually make its way into a HERS score?
  - Potentially a large effect on the market.
- ASHRAE 62.2 Home ventilation standard – how does ventilation affect heating and cooling energy use. Michael Lubliner opines its probably a second-order effect, in the noise.

Open Discussion

Next Metrics Meeting

- March TBD

Contact Information

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