ENERGY STAR Connected Thermostats

CT Metrics Stakeholder Meeting Slides

September 27, 2022

Attendees

Abigail Daken, EPA
Abhishek Jathar, ICF for EPA
Alan Meier, LBNL
Leo Rainer, LBNL
Eric Floehr, Intellovations
Craig Maloney, Intellovations
Michael Blasnik, Google/Nest
Kevin Trinh, Ecobee
Yufeng Deng, Ecobee
Brad Powell, Carrier
Jason Thomas, Carrier
Theresa Gillette, JCI
Rohit Udavant, JCI
Diane Jakobs, Rheem
Carson Burrus, Rheem
Chris Puranen, Rheem
Glen Okita, EcoFactor
John Sartain, Emerson
Eric Ko, Emerson
Albert Chung, Emerson
James Jackson, Emerson
Daniel Stephan, Emerson
Mike Lubliner, Wash State U
Charles Kim, SCE
Michael Fournier, Hydro Quebec
Robert Weber, BPA
Phillip Kelsven, BPA
Casey Klock, AprilAire
Sergio Marques, Stelpro
Kristin Heinemeier, Frontier Energy
Ulysses Grundler, Trane
Michael Moore, Trane
Mike Caneja, Bosch
Sarathy Palaykar, Bosch
Mike Clapper, UL
Alex Boesenberg, NEMA
Ethan Goldman, Resilient Edge
Jon Koliner, Apex Analytics
Hassan Shaban, Apex Analytics
Michael Siemann, Resideo
Arnie Meyer, Resideo
Aniruddh Roy, Energy Solutions for CA IOUs
Jia Tao, Daikin
Dave Winningham, Lennox
Dan Poplawski, Braeburn
Natasha Reid, Mysa
Howard Rideout
Peter Gifford, Mysa
Sylvain Mayer, Sinope Technologies
Caroline Cote, Natural Resources Canada

Agenda

- V2.0 Draft 1 specification and test method feedback
- Climate zone weighting
- Control of dual fuel systems

V2.0 Draft 1 specification and test method feedback

- Missing data recap:
  - A data set with no runtime data gaps > 1 hour (valid data) for 95% of days in a reporting period is considered complete.
  - Data sets with valid data from less than 95% of days are considered complete if they have at least 50 core days.
- No feedback on missing data proposal, despite the fact that we know it'll be a problem for some of you.
- Start collecting the data now to ensure you've one year worth of data to meet proposed requirements by the V2.0 specification effective date.
- EPA is actively working on Tau friendly regression and plans to incorporate the same in Draft 2 subject to budget constraints

V2.0 Draft 1 specification and test method feedback

- Line Voltage thermostats:
  - Should LVTs be considered single stage in the software input files?
  - Define the maximum number of thermostats per household to be included in the field savings analysis.
  - Evaluate whether US metrics and savings will be applicable to Canada.
- Non-metric related topics to be discussed at a separate venue like 1-1 calls
  - Standby power consumption feedback:
    - Propose separate standby power consumption limits for low voltage and line voltage thermostats
    - Can LVT vendors provide data so that EPA has a robust data set?
    - Low voltage manufacturers echoed concerns that LCD touch screens will consume > 1W.

V2.0 Draft 1 specification and test method feedback

- Additional DR capabilities:
  - STs with DR functionality can incorporate open communication standards that include the following criteria: cybersecurity, interoperability, easy configuration, direct load control capability, and responsiveness to energy price signals and system emergency.

- Topics requiring detailed investigation and analysis (Not likely for V2.0)
  - Consider the bin fractions outlined in DOE's CAC/HP federal test procedure.
  - Characterize and optimize all possible auxiliary heating approaches in electric and gas-fired modes (e.g., dual-fuel heat pumps) to maximize the performance during the heat pump vapor-compression.

Discussion: V2.0 Draft 1 specification and test method feedback

- Coding LVT as single stage or variable speed: No opinions on the call – general consensus that more discussion will be needed. Some use wave train operation rather than pulse width modulation. Similar result – able to modulate output power. One stakeholder has been using (duty cycle*interval duration) as the run time.
  - Do LVT vendors record duty cycle or something similar for every interval? One stakeholder says yes; EPA would like to hear from everyone
  - May be able to use the effective full load run time structure to deal with this.
- Pointed out that thermostats controlling boilers for hydronic systems sometimes use PWM or some similar short-interval on/off (on the scale of minutes) to modulate the gas input to the hot water tank. Sometimes the boilers do something similar themselves, in which case the thermostats will not.
  - Is this common? More than you might think, including 3rd party thermostats.
  - EPA will follow up later.

Discussion: V2.0 Draft 1 specification and test method feedback

- Re max # thermostats to be included in the sample?
- Will the vendors know how many thermostats are in the same home? Note that it's not uncommon to have just a few rooms in a home with smart thermostats while the others have unconnected thermostats.
- Given all this, should we allow only one thermostat in each home to be included in the home? And if it's only one, can we apply some intelligence as to which one, e.g. the one used the most? One vendor says smart LVTs are most likely to be used in locations with high run time.
- Can sizing be part of the selection of LVT in each home? Do vendors have this information? At least some thermostats can detect this (not user input).
- Also an issue for low voltage thermostats – the sample over-represents homes that have more than one thermostat.
    - Run of installations of multi-thermostat homes showed much higher attrition rate (bad fit or tau) particularly for heating in cold climate than for the random sample for resubmission. Also true for vacation homes with a lot of unoccupied time. For those that survived, metric scores were about the same.

Climate zone weighting

- Discussion Guide comment: Consider different weighting, e.g. half even weighting, remainder as per Version 1.
- Additional Draft 1 comment: Consider using IECC climate zones, not BA, because they're smaller and will give more representative results. Too heavy a lift for V2.
- Context
  - Avoid false precision, keep it simple
  - Already having trouble with new products on market having sufficient deployment in all climate zones to certify
  - Current weighting (by % of national heating/cooling energy use) accurately represents of national savings, but doesn't reflect users as well
  - Have also considered weighting by % of households in each climate zone
- May exacerbate issue of small # of users in some zones

Discussion: Climate zone weighting

- Current weighting definitely doesn't work for Canada – heating-only vendors may not have sufficient installations in hot climates; Arctic zone isn't even included – how many homes are there?
  - Heating savings scores tend to have lower heating savings scores anyway, so thresholds may need to be different in Canada – though all vendors do meet the metric requirements in cold/very cold considered independently.
- If we weighted the cold climate region less, HS scores would go up. Almost double the scores in the less cold places.
- The current weighting is based on an old RECS survey, at minimum we should update based on 2020 survey.
- No one is sure what weighting by household type would do, though it's hard to imagine that it would be more even.
- Could the original comment be based on a misunderstanding that the scores in milder climates are likely to be lower than the national heating and savings scores?
- Note that for heating-only thermostats, in addition to few installations in cooling dominated climates, thermostats may be off-line during the cooling season.

Control of dual fuel systems

- Increasing interest in heat pumps with fuel backup.
  - Not always controlled by the same thermostats, and
  - Often the heat pumps are variable speed cold climate.
  - Leaving aside these problems, can we ID "good enough" control of fuel backup for centrally ducted single and 2-speed heat pumps?
- Framing questions:
  - How many systems have single or dual capacity heat pumps with fossil backup?
  - Do these also have electric strip backup?
  - Is the thermostat in charge of the decision of when to call on backup heat?
  - What would the model fits for such systems look like?
- What does the thermostat know?

Discussion: Control of dual fuel systems

- One vendor: 2% of systems are single- or dual-capacity heat pumps with fossil fuel backup (distinguishable from wiring). Some have 2 stages of gas, some have 2 stages of compressor (more rare than single stage for both). How likely to be mis-wired? Well, some possibly but not many. These systems do not have strip heat as well? Not wired as such – not supported. Expect fuel backup almost entirely gas, but can check reported fuel types.
- Another vendor: we support these systems, but can't really track and distinguish between strip heat and fossil fuel backup. Controls likely not optimized. However some 3rd party vendors are developing applications to address this.
- Not clear what the efficiency opportunity is here – most crossover temps would be between 45 and 30 F.
- Note that DOE default energy penalty for defrost energy assumes heat pumps are sized for cooling (can test instead). Control solutions for defrost may also depend on these sizing assumptions.
- Jeremy Sager (CanMet) has some interesting results on this – Caroline and Kevin will follow up.

Discussion: Control of dual fuel systems

- For aux heat in general, there are several means for the thermostat to decide when to call on it (in installer menu).
- Another vendor: when the system has strip heat backup and is set to stage when it doesn't satisfy the call in a given amount of time, the heat pump can call backup. Typically for fuel-fired backup (separate system), the thermostat will be the one calling backup.
- Utility program (Canada) configured to change fuels when the temperature measured next to the meter is below -12C, then sends a signal that switches the fuel used for heating, so the thermostat has no information about which fuel is being used.
- Something similar is used that prevents a heat pump compressor from running when it's too cold out.
- Note also that there is growing interest in using dual fuel systems for demand response, so that will affect when each system is running.

Open forum: topics from attendees

- Noticed that there was a study recently released re-analyzing data from a 2012 recruit-and-deny pilot of a single brand of connected (not smart) thermostat compared to a regular thermostat, showing no savings. New study is from National Bureau of Economic Research.
  - Reanalyzed a lot of data (why?), same calculation (0 savings), but concluded
  - "Smart thermostats as a class don't save energy." (why?)
  - Note that the thermostat itself was a pre-release product and something of a kludge, with the sophisticated user interface only on an app, not on the hardware.
  - Atlantic Monthly picked this up (Why? Who knows!) and published an article on it, with a photo of a modern smart thermostat. Misleading.
  - How much will this get picked up?
- Several vendors were contacted for comment, but with just a few hours to review and comment, and then the article wasn't much updated.

Open forum: topics from attendees

- Many more problems with the NBER study identified. Suffice it to say that it really doesn't hold up.
  - Assumes that all smart thermostats are the same but references an Energy Trust of Oregon study from 2016 showing that two going head-to-head had vastly different results.
- Collaborate with ACEEE on a statement in case they feel like it makes sense to make one?
- Links shared by stakeholders:
  - Link to Jeremy Sager's dual-fuel research: https://www.proquest.com/openview/3052f2df50598f2fc95d9998562c3b15/1?pq-origsite=gscholar&cbl=34619
  - PPT: https://buildingknowledge.ca/wp-content/uploads/2018/05/CanmetENERGY_Hybrids_Spring-Training-Camp-2018_dissem.pdf
  - Hydro-Quebec tariff reference: https://www.hydroquebec.com/residential/customer-space/rates/rate-dt-how-it-works.html