



# **ENERGY STAR Connected Thermostats**

## **Stakeholder Working Meeting Field Savings Metric**

September 16, 2016



## Attendees

Abigail Daken, EPA

Doug Frazee, ICF International, for EPA

Dan Baldewicz, ICF International, for EPA

Alan Meier, LBNL

Marco Pritoni, LBNL

Ethan Goldman, VEIC

Nick Lange, VEIC

Michael Blasnik, Nest Labs

Adam Brouwer, Carrier

Paul Kinningham, Carrier

Phil Ngo, Impact Labs

McGee Young, Impact Labs

Brent Huchuck, Ecobee

Nkechi Ogbue, Ecobee

Wade Ferkey, AprilAire

Jack Callahan, BPA (retired)

Michael Siemann, Weatherbug Home

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

Chris Smith, 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

Paul Jackson – UL

Essie Snell, eSource

Theresa Weston, DuPont

Dave Manfield, Carrier

Michael Fournier, Hydro Quebec



## Agenda

- Software status update
- Upcoming Data Call
- Method to Demonstrate Field Savings
  - A standard method for generating random CT data sets
  - Minimum sample size
- Planned milestones



## Status Update: Software dev

- Beta software was released early morning 9/16/2016 as well as a CT Metrics Discussion Document
- Key changes
  - Baseline comfort temperatures are assessed from  $T_{\text{indoor}}$  history
  - Data filtering is implemented
    - Filter out CT instances where  $\text{Tau} < 0^{\circ}\text{F}$  or  $>25^{\circ}\text{F}$  for heating (cooling)
    - Tau filtering plus filter out CT instances where  $\text{CV}(\text{RSME}) > 0.6$  for heating (cooling)
    - Tau and CVRSME filtering plus filter out CT instances where % heating (cooling) savings are in the top or bottom 1%, 2%, 5% of all CTs in that EIA climate zone



## Status Update: Software dev

- Key changes (cont.)
  - Savings separately output without filtering and after application of each filter
  - All outputs of savings include both
    - Mean savings
    - The lower bound of the 95% confidence interval
  - EPA is considering mandating that the lower bound of the 95% confidence interval comply with minimum energy savings criteria to earn the ENERGY STAR



## Discussion: Software dev

- Like idea of using lower bound – have seen it suggested but never used. Is EPA following or setting a precedent?
  - Something similar is used for EPA verification test
  - Also, something similar is used in the AHRAE guideline 14 fractional savings uncertainty – still uses the mean as long as the savings uncertainty is low enough
- How is 95% calculated? Per climate zone or nationally?
  - Calculated both, but likely to set requirements based only on national results
- Assert it should not be up to the vendor what sample size they use
  - Current thinking: EPA minimum, but larger sample acceptable. Discussion to follow.
  - Several more comments, to be explored in following discussion.



## Data Call

- EPA plans a call for data to inform the Draft 3 CT specification – this effort will launch imminently with details to follow
  - Inform minimum metric score
  - Inform final method to assess field savings
  - For this data call
    - Participants are asked to submit the software tool output file to ICF International
    - Data over a recent 12-month period is preferred but different date ranges or time periods may also be used
    - Additional details are in the data request
  - EPA will release a summary of findings, submitted files will not be publically released



## Discussion: Data Call

- Will passing criteria be the same in each zone?
  - Not currently expecting to have requirements per each zone
  - Weighted average of zone results give national results; the possibility exists to exclude certain zones from national calculation of cooling or heating, if there is a small contribution of that zone to heating/cooling energy use.
  - Any such decision would be discussed with the stakeholder metrics group before being finalized



## Method to Demonstrate Field Savings

- EPA is striving for a ENERGY STAR CT program that is both meaningful to the marketplace as well as robust, while minimizing stakeholder burden
- To achieve these goals, we are considering the following elements of the method to demonstrate savings:
  - A standard method for generating random CT data sets
  - Minimum sample size
  - Auditability
    - Standardized method for random data set
    - Standardized process and software for assessing field savings
    - 5-year data retention



## Field Savings - CT data set selection

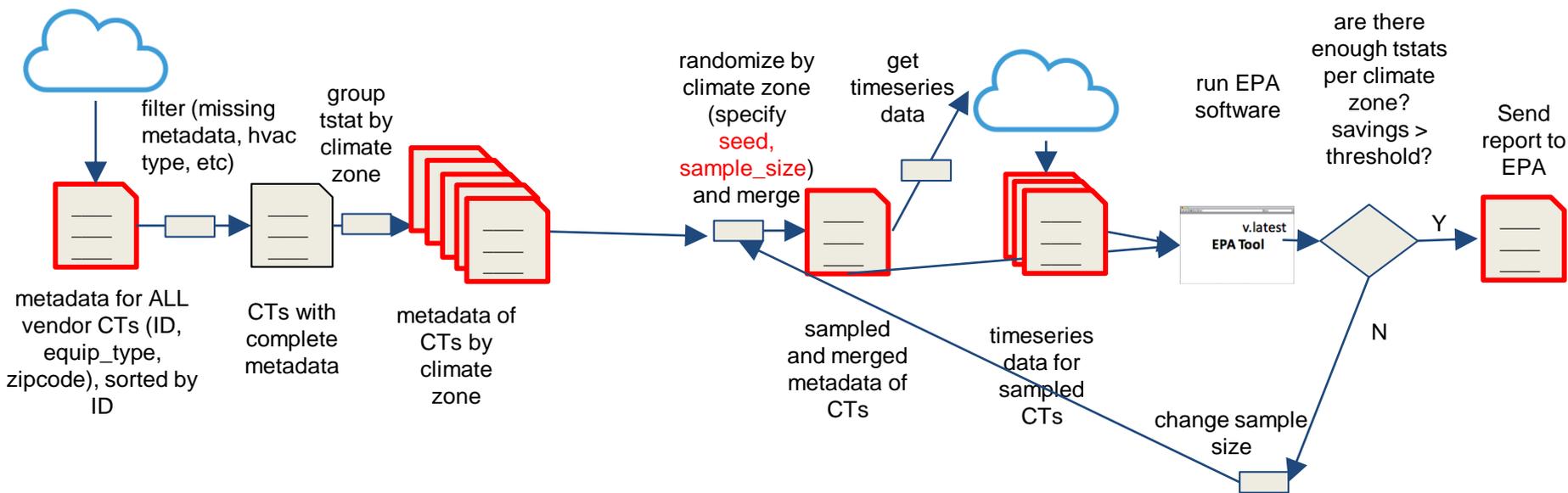
- Motivation & Goals
  - Stakeholder feedback irt 3<sup>rd</sup> party verification
  - Implement randomized methodology for data set generation that is:
    - Standardized
    - Auditable
    - Minimizes stakeholder burden
    - Protects program integrity
    - Guards against “cherry-picking”



## Field Savings - CT data set selection

- Considered process
  - Generate a separate metadata file for each of the 5 EIA Climate Zones that include all instances of a CT model, ordered by the unique CT ID
  - Using the following python functions along with a seed supplied by EPA, generate separate CT data sets for each climate zone:
    - `numpy.random.seed( seedvalue )` #specify seed
    - `numpy.random.choice(tstatList, sampleSize)` # select the sample
  - Execute ENERGY STAR software tool
  - Repeat, as needed e.g. to adjust sample size
  - Retain metadata files and all CT files used to assess savings for at least 5-years

## Proposed Process



### Legend:

**red**: data retained by vendors (only the report is shared with EPA)

processes are described above the rectangle

data are described below the figure



## Discussion: CT data set selection

- Why do we need something this involved? With seed, you know exactly which products are sampled, so you can play with thermostat ordering to cherry pick. Must specify sort order to truly prevent cherry picking
  - Sort by SN alphanumeric?
  - Sort by date product first came on line
  - Can then use systematic sampling if you know the sample size
  - The same seed and function can potentially also give a different set of selections depending on which processor and operating system it's running on.
  - A similar standard deviation from vendor to vendor would allow choosing sample sizes.
    - Could have a threshold based on total installed base or sales or something
- Prefer serial number because it's a deterministic sort, whereas by date several thermostats could have the same one. Sort by thermostat ID?
  - This is what EPA suggested



## Discussion, continued

- Thoughts on sorting by thermostat IDs?
- Anyone object to a systematic sampling? Any advantage from using a different seed in different years or for different vendors?
  - Many of the same ends could be served when using a systematic sampling
  - Instead of a minimum sample size, could also have a minimum sampling frequency.
  - Doesn't seem to matter too much, as long as the order is specified
  - Valid point, but re gaming the system: how do we know that the initial list of all installations is complete? For instance we will likely exclude 'stats that have only been on line for three weeks. Sounds like we need to flesh out the list of metadata required.
  - Need to be specific about exactly what filters happen (consistently at all vendors) at which stage.
  - There is a concern that the initial list of all installations (first doc needed to be saved) could be manipulated. Can there be a way for the auditor to ask for fresh download and get the same result at a later date?
- Side note – include in metadata the last time the thermostat checked in with the service? And what do we do with it.
- One vendor currently considering eliminating raw data more than three years old. Metadata could be retained indefinitely, but the metadata could also change.



## Discussion, continued

- If metadata changes, could create problems for auditing. If we have all the columns that the filtering is done on (dates, HVAC types, etc). Can you track that a single thermostat has a (e.g.) HVAC type at one time and a different one at different time?
  - Not easily, but maybe
  - Yes, we can



## Field Savings – minimum sample size

- Savings for heating and cooling are separately evaluated in 5 climate zones
- The ENERGY STAR CT savings software may exclude a number of CT instances from the assessment of mean savings
- In each of these 10 regional savings assessments, EPA intends to specify that a minimum number of CTs are used to determine the mean
- EPA requests stakeholder feedback on minimum sample size
  - 250 has been suggested, but might result in a barrier to entry for some CT service providers
  - Data filtering will vary by climate zone and is expected to be high in milder climates
  - Can a lower sample size be specified without impact to program integrity?



## Discussion: minimum sample size

- Energy use as a proportion of national consumption is very low in certain use cases, would it be helpful to exclude one or more of these from the assessment of national savings?
  - Marine cooling is 0.5% of national energy consumption
  - Marine heating is 3.6% of national energy consumption
  - Hot-Humid heating is 4.9% of national energy consumption
- Five climate zones:
  - 1) Marine, 2) mixed dry+ hot dry, 3) cold + very cold, 4) hot humid, 5) mixed humid
- Should minimum sample size depend on the vendor's installed base?
  - One vote for yes
  - For new vendors, could also require use all you've got until you get large enough to sample



## Discussion: minimum sample size

- Anyone have objections to minimum sample size applying to the thermostats actually used to determine statistics?
  - Yes, sort of, makes process more complex if you need to go back and reselect another sample (can live with it)
  - If you end up with a smaller sample at the end, won't your terrible confidence interval require a larger sample anyway?
- Distribution of savings between homes may not be Gaussian, so do the rules of thumb of sample sizes apply?
  - Central limit theorem applies even if the underlying distribution of the population is not Gaussian, but the number of samples you need for the central limit theorem to apply, depends on the underlying distro. 30, 50 and 100 were sample sizes thrown out for this.



## Planned Milestones

- September 2016
  - Discussion Document detailing candidate methods for demonstrating CT field savings & software implementation
  - Beta software release
  - Data request using new software, to inform selection of methodology and minimum % savings
- September 2016 – Draft 2 ENERGY STAR Method to Demonstrate CT Field Savings
- October 2016, with results of data request
  - Draft 3 ENERGY STAR CT Specification
  - Final Draft ENERGY STAR Method to Demonstrate CT Field Savings



## Planned Milestones (cont.)

- October 2016 – V1.x ENERGY STAR CT Field Savings software
- November 2016
  - Final Draft ENERGY STAR CT Specification
  - Final ENERGY STAR CT Method to Demonstrate Savings
- December 2016 – Final V1.0 ENERGY STAR CT specification  
effective upon release



## Discussion

- Michael plans to do some sensitivity analysis with the beta software (0.4)
  - Definition of core heating/cooling days
  - How do heat pumps look in this?



## Contact Information

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