



# **ENERGY STAR Connected Thermostats**

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

July 1, 2016



## Attendees

Abigail Daken, EPA

Doug Frazee, 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

Adam Brouwer, Carrier

Paul Kiningham, Carrier

Matt Golden, Open EE

Phil Ngo, Impact Labs

McGee Young, Impact Labs

Brent Huchuck, 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

Michael Lubliner – Washington State University

Dave Piecuch – UL

Paul Jackson – UL

Essie Snell, eSource

Theresa Weston, DuPont

Paul Skorochood, ICF International, for EPA



## Agenda

- Software Development Update
- Request for Investigation into Data Filtering
  - drivers/need
  - delivery of findings
- Projected Dates & Milestones



## Software Development Update

- Code review conducted prior to latest release
- Several raw CT data sets have been provided to ICF and OEE
- Current Release: Alpha v0.3.3
  - Internal testing completed
  - Has been run by one stakeholder thus far, without issue
  - Adds ability for variable data filtering rules to be investigated



## Software Development Update (cont)

- Changes & bug fixes
  - Fixed Delta T cooling objective function:  
 $\text{minimize}(\text{runtime} - \alpha * (\text{demand\_deltaT} - \tau))$
  - Fixed Delta T heating objective function:  
 $\text{minimize}(\text{runtime} - \alpha * (\text{demand\_deltaT} + \tau))$
  - Added missing check for insufficient temperature\_in and temperature\_out data
  - Fixed sign error in percent savings calculation
    - Directly calculated baseline runtime deltaT (cooling) method as  $\text{maximum}(\alpha * (\text{baseline\_cooling\_demand} + \tau), 0)$
    - Directly calculated baseline runtime deltaT (heating) method as  $\text{maximum}(\alpha * (\text{baseline\_heating\_demand} - \tau), 0)$



## Software Development Update (cont)

- Changes & bug fixes
  - Fixed sign error in percent savings calculation
    - Directly calculated baseline runtime hourly/daily HTD/CTD as  $\text{maximum}(\alpha * (\text{baseline\_demand}), 0)$
    - Calculated avoided runtime as: modeled baseline runtime - observed runtime
  - Plotted fits to verify correctness using new data.
  - Better agreement between results with the three methods
- Documentation:  
<http://thermostat.readthedocs.org/en/latest>
- Source code: <https://github.com/impactlab/thermostat>



## Discussion

- none



## Request for Investigation into Data Filtering

- Previous data call was unable to inform level setting or savings method selection
- Root causes
  - Outliers strongly impacted mean and median savings
  - Insufficient filtering rules - CTs with problematic, even non-physical thermal models were not excluded
  - Bugs existed which affected calculations (now fixed)





## Request for Investigation into Data Filtering (cont)

- Alpha release 0.3.3 enables experimentation with type, order and level of data filtering:
  - Limit maximum and minimum levels for  $\tau$  the balance temperature
  - Limit the max RMSE for the CT thermal – run time models
  - Trim CTs with very high calculated savings, based on a % of the relevant pool of CTs
  - Trim CTs with very low calculated savings, based on a % of the relevant pool of CTs
- Informal investigation, software is ready now
- Provide results to Doug Frazee, ICF International
  - [dfrazee@icfi.com](mailto:dfrazee@icfi.com) (443) 333-9267
- Please target delivery of findings by July 18, 2016



## Data Filtering Code Documentation

- Will be posted to the Connected Thermostat PD webpage:
  - [https://www.energystar.gov/products/spec/connected\\_thermostats\\_specification\\_v1\\_0\\_pd](https://www.energystar.gov/products/spec/connected_thermostats_specification_v1_0_pd)
  - Contains: Instructions, Filters and recommended order, Sample Limits, Location for filtering code in Quickstart Program, and Code.
- By July 18<sup>th</sup> 2016, participants please send the following to [Dan.Baldewicz@icfi.com](mailto:Dan.Baldewicz@icfi.com) and [Douglas.Frazee@icfi.com](mailto:Douglas.Frazee@icfi.com):
  - [Feedback] For each metric (DeltaT, Daily, Hourly), which filters to apply and at what levels.
  - [Files] Raw statistics module outputs for your recommended filters:
    - Control (No Filters), Filters applied to DeltaT, Filters applied to Daily, Filters applied to Hourly.



## Discussion

- Any insight on why some of the nonsensical results were occurring? Have the causes been addressed?
  - Some outliers and nonsensical results were traceable to specific software errors.
  - The majority are based on homes that do not fit the model, and our intention is to trim them out.
  - EPA limited in ability to track down causes w/o data
- How many data sets?
  - In old version, there were not that many outliers – 1% would affect standard deviation by order of magnitude; further trimming had smaller effect but 2-3% looked good
  - In old version, RMSE filtering didn't work well
  - In new version, mean looked pretty good, but 1% trimming on either end now reduces standard deviation by 1/3.
  - Generally seems like software returning more sensible results, now looking at throwing out 1%-2% of thermostat



## Projected Dates & Milestones

- Completed Alpha V0.3.3 ENERGY STAR CT Field Savings software
- Now thru July 18, 2016 – Stakeholder investigation into data filtering
- Early August 2016 – Beta software release, incorporating
  - 3 candidate savings methods
  - 2 Baselining methods
    - Occupant preferred comfort temps (10/90<sup>th</sup> percentile of set point history)
    - Comfort temps by EIA/RECS climate zones
- Early August 2016 – Data request using new software, to choose method and proposed levels
- Late August/ Early September – results of data request



## Projected Dates & Milestones

- September 2016
  - Draft 3 ENERGY STAR CT Specification
  - Draft 2 ENERGY STAR CT Method to Demonstrate Savings
- 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



## Contact Information

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