Claiming Savings from Smart Thermostats: Guidance Document

Northeast Energy Efficiency Partnerships, April 2017

The Opportunity: Significant Savings Potential

Efficiency programs, pilots, evaluations, and whitepapers throughout the country have documented the savings *potential* of smart thermostats,[1] ranging from lows of zero or even negative savings to upwards of 20 percent savings. The high-level summary of these reams of analysis is that, in many cases, there is energy to be saved through use of smart thermostats. Smart thermostats are now transitioning from a pilot measure to being included as a permanent and significant measure in rate-payer funded efficiency programs throughout the Northeast, Mid-Atlantic, and beyond. This guidance document provides background and instructions for program administrators (PAs) to use the data collected by the devices themselves to calculate energy savings for a program.

The Challenge: Control Technologies Aren't "Efficient"

Smart thermostats save energy by **optimizing** use of HVAC equipment; this occurs through a variety of means, such as occupancy detection and automation, advanced HVAC control to use less energy for equivalent comfort, or encouraging occupant behavior change. While as a category, smart thermostats has shown a yield of significant savings in many cases, the expected savings of an individual home depends on individual factors, such as:

- type, age, and configuration of the HVAC system;
- details of the specific house, such as floor plan and envelope thermal efficiency;
- climate and seasonal impacts; and/or
- occupant behavior and preferences, including occupancy schedule.

While any efficiency measure faces a degree of uncertainty when calculating savings (e.g. realized savings from a newly-purchased lightbulb depends on what type of bulb it replaces and how often that light it on), programs and evaluators find ways to manage the uncertainty through statistically rigorous studies. One example is socket saturation and hours of use studies for lighting. Smart thermostats, however, have both significant per-unit savings potential as well as a high level of uncertainty when compared to more traditional one-for-one efficient measures.

[1] NEEP Opportunities for HEMS in Advancing Residential Energy Efficiency Programs, http://neep.org/opportunities-home-energy-management-systems-hems-advancing-residential-energy-efficiency-programs 2015 Table 4 and Appendix C, Fraunhofer's https://www.cta.tech/CTA/media/policyImages/Energy-Savings-from-Five-Home-Automation-Technologies.pdf table 2-2, https://www.clearesult.com/insights/whitepapers/guide-to-smart-thermostats/ page 22.

The Need: Data-Driven Savings

While responsibly applying a savings value across homes with smart thermostats is complex,[2] the industry is in luck. Inherent in the design of smart thermostats is their ability to collect **data** about their operation, as well as information such as set point, indoor temperature, and outdoor temperature. This data can be analyzed to provide calculated savings from real-world homes. This is different from the deemed savings approach taken for many residential efficiency products, but is a more accurate and realistic way to claim savings on a control device.

The Tool: ENERGY STAR's Smart Thermostat Specification and Metric

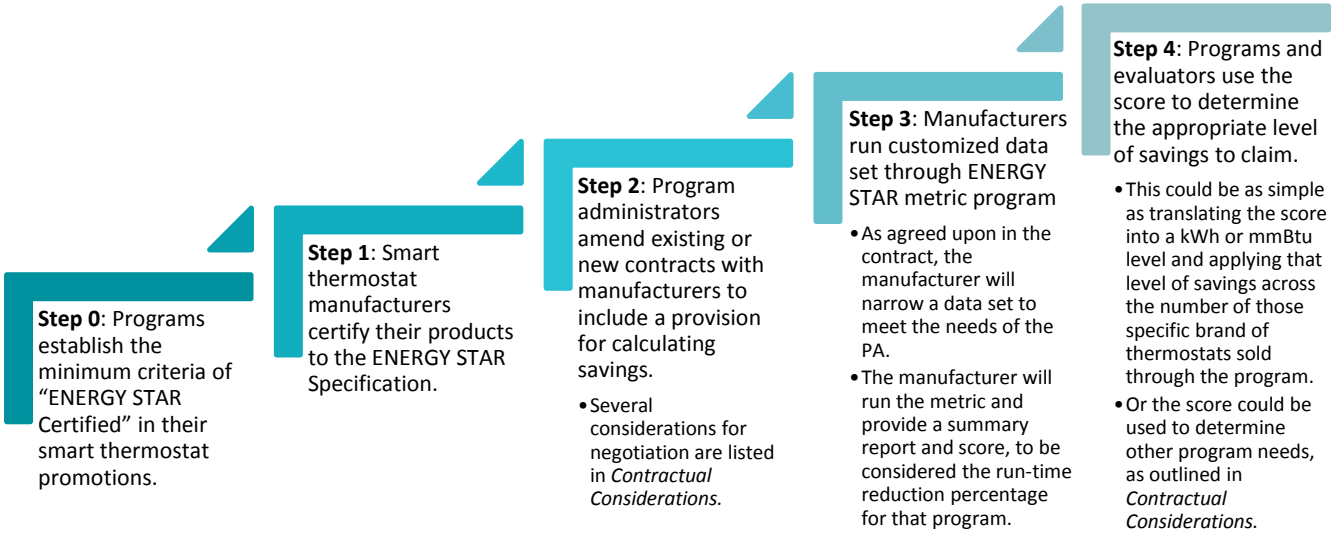
The US Environmental Protection Agency (EPA)'s ENERGY STAR® program has taken on the tremendous job of designing, building, and implementing a specification for smart thermostat products. This specification[3] sets basic requirements for the devices, such as standby power draw and functionality in different settings, and has a companion metric tool that calculates the run-time reduction of HVAC equipment using manufacturer-supplied data coming from installed thermostats throughout the USA (submitted by climate zone[4]). The percentage reduction in run-time is calculated and aggregated across climate zones, weighted by their energy-use intensity, and then compared to a value set in the ENERGY STAR specification. If a product meets the basic specification requirements and its data shows a runtime reduction score of at least eight percent heating and 10 percent cooling, it earns the ENERGY STAR label. The exact score of a specific product in any one climate zone, however, is not reported by ENERGY STAR; all products on the qualified products list (QPL) must have scored at least eight percent heating and 10 percent cooling reduction, but in some instances may score higher than that. This methodology and the specification were developed through extensive stakeholder input and represent balanced, statistically-significant assurances that those products that earn ENERGY STAR recognition are superior in energy savings potential for an average consumer than non-ENERGY STAR-qualified thermostats.

In addition to the ENERGY STAR specification being a powerful tool for program administrators to determine which products should be promoted, it also sets up the framework for thermostat manufacturers to run specific sets of data through the ENERGY STAR metric software and submit aggregated and analyzed data summaries to certification bodies for review. This opens a crucial opportunity for collaboration between program administrators, thermostat manufacturers, and service providers to develop *customized data sets* that meet the needs of the program to be run through the ENERGY STAR metric; this could, in turn, yield a customized savings number which will be much more accurate for programs looking to claim credit from this category.

[2] http://neep.org/smart-energy-home-strategies-transform-region Strategy 3.
[3] https://www.energystar.gov/products/spec/connected_thermostats_specification_v1_0_pd
[4] https://www.eia.gov/consumption/residential/maps.php

The Process: How This Really Works

The four-step process outlined below hinges on the "Step 0" that programs would use the ENERGY STAR Smart Thermostat qualified products list as the basis for determining which models are eligible for the program offering. Subsequent steps are a series of conversations and negotiations between program administrators, smart thermostat manufacturers and service providers (henceforth referred to only as "manufacturers"), evaluators, and potentially additional parties.



Contractual Considerations: Establish These Up-Front

Before any negotiations between program administrators and manufacturers take place, programs need to ask themselves the following potential questions:

What geography should this analysis pull from?

- While in theory, data could be analyzed down to the zip-code level, a larger starting sample will yield more applicable results as well as be less costly and burdensome to run. Program administrators should consider asking for state-level or even sub-regional data be included in the analysis and partner with neighboring programs to determine one data set.

What timeframe and season(s) are you looking for?

- Are you looking to claim heating season degree day and/or cooling season degree day savings? How many seasons back do you want to look? These timing considerations are crucial to limit the data to the needs you have. Note that the EPA metric is likely to vary slightly from hot years to cool years, and is not calculated with any automatic correction for this effect.

Do you have additional restrictions based on program needs?

- Are you only looking for specific HVAC equipment type? Only homes with central air conditioning and heating controlled by the thermostat? Are you planning to base a significant amount of your savings claim on reduction of backup strip heating? Different HVAC systems may need different consideration; strip heating savings, for example, is not reflected in the metric score. Screening homes to meet HVAC specific considerations may end up shrinking your sample size significantly.

What will be used as the thermostat set-point baseline for your analysis?

- ENERGY STAR's metric employs methodology developed by the Fraunhofer Center for Sustainable Energy to set a baseline for each home using the data reported by the smart thermostat for core heating and core cooling days to determine the occupant's preferred comfort temperatures for heating and cooling.[5] This methodology provides a much better estimate of actual baseline activity than taking a general average, but if a specific average set-point baseline has been rigorously established through studies specific for your territory, that number could be input into the ENERGY STAR metric.

What are you using as your HVAC usage assumption?

- Through the ENERGY STAR metric, programs can get specific runtime reduction percentages; this is the percentage, but programs need to establish an answer to "percentage of what?"
  It is critical to ensure that you've established the average HVAC energy usage for your territory, which in many cases has been determined through evaluations or RECS[6] data. The ENERGY STAR process will provide an aggregated average specific runtime reduction for a specific brand of thermostat, but that number will need to be applied to something in order for savings to be calculated.

How many data points are sufficient for your program?

- EPA uses a starting dataset of 250 homes for each climate zone, a sample size they have determined to be sufficiently large. For smaller service territories, there may not be 250 viable datasets for analysis, in which case all viable datasets should be used. In situations without shortages of homes, 250 should be considered the maximum number of homes necessary for a rigorous analysis. The software outputs both the uncertainty of the mean as well as the mean savings of the sample of homes.

How often do you want to calculate this score? What lifetime considerations do you have?

- The metric score from a manufacturer is submitted to EPA every six months for the previous season to retail listing on the QPL; this creates the opportunity to re-calibrate lifetime savings of the measure based on new data coming in. To date, the season-over-season variability of smart thermostat savings has not yet been demonstrated.

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[5] Methodology described in https://www.energystar.gov/sites/default/files/Nest%20Supplementary%20Comments.pdf section 3.1.2
[6] https://www.eia.gov/consumption/residential/

What will all this information be used for?

- Is this only to claim savings for a program year? Will this information also be used to determine an incentive level or a retroactive pay-for-performance model? If so, having a spelled out approach with the manufacturers is necessary.
  For example, setting up an agreement where in year one, the data from the analysis will be used to claim savings for that program year, but in year two, the year one data will be used in cost-effectiveness calculations to determine an appropriate incentive level. This may result in different brands of smart thermostats receiving different incentive levels.

Who will be responsible for data analysis?

- For the ENERGY STAR certification, manufacturers are responsible for running an appropriate data set through the metric program and providing a summary report to a certifying body for review. A similar approach could be taken in this case, where a manufacturer would run the customized data set through the metric and provide the summary report and score to the program administration and/or a third party evaluation consultant. The party responsible for review of data will need to be established before the data are run.

Conclusion: A Better Way for a Brighter Future

As with any change in approach or methodology, it will take time to adjust. NEEP recommends that program administrators begin conversations with regulators, evaluators, and manufacturers immediately to begin to establish this approach for claiming savings. Once a reliable savings calculation methodology is in place, it is NEEP's belief that more savings will be able to be reliably claimed, and that smart thermostats will not only prove to warrant a larger incentive, but that this measure will be able to earn a permanent place in rate-payer funded programs. NEEP remains a resource to help stakeholders succeed in this space.

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