sensi™

Energy Savings from Sensi

DEC. 2019

SUMMARY

This white paper describes the collection and analysis of data that supports an estimate of potential energy usage savings based on parameters, conditions and assumptions provided to us by residential Sensi users. The energy usage savings is an estimate and the results presented may not reflect the actual savings. Energy savings are calculated by comparing operation time for a nationwide sample of Sensi users with temperature adjustments averaging 4° in comparison to users with no adjustments. Actual savings will vary based on the size and frequency of temperature adjustment, as well as occupancy, climate, housing characteristics, heating and cooling equipment, age and condition of equipment, home insulation, energy provider, state average utility cost, energy usage, and other factors.

METHODOLOGY

Sensi compared HVAC equipment run times for two populations, those using setback and those not using setback. Method is analogous to comparing fleet mileage between two set of drivers based on their driving habits over a large range of vehicles. This is not an A-B test where operation with and without setback was compared in otherwise equal conditions. That would require identical homes or identical conditions for the same home over time. This would also require the occupants to have identical behaviors including occupancy, cooking, bathing, etc. These conditions are understandably very hard to obtain and even harder to obtain for a statistically significantly sample. A 2unit A-B test has been done and found similar benefits to setback.

Data was collected from 2016 Sensi usage. Usage data was not originally collected to feed this study, but used for general validation of product operation. No incentive to use setback was provided other than the generally well distributed concept that it could save energy or money. Some anticipated bias exists that purchasers of a programmable or connected thermostat would use the setback feature. Other historical data suggest that a moderate portion of purchasers of programmable thermostats do not use the setback feature. This evaluation found that the ratio has improved to over 80% of customers using setback. The study only knows the data from the thermostat and the zip code of the home.

Individual run times may vary greatly from the average or median for each population. The sample includes a wide, unknown and uncontrolled population of the following factors:

· Home age
· Insulation level; Air infiltration; Duct leakage; Solar load.
· Climate zone
· Use profile; Occupancy profile
· Residential, commercial, instructional spaces.
· Equipment condition.
· Equipment size.
· Equipment size to Ft^2 ratio.
· Number of systems in the home.
· Presence of other heat sources in the home / space.
· Presence of large heat loads (kitchens, locker rooms, non-traditional spaces).

SELECTION CRITERIA

1. Sensi thermostat was connected and registered.

2. Zip code associated with their account. Zip code is used for climate zone comparison.

3. Connected to Wi-Fi at least 80% of the time. Needed to be connected for the duration of the study and had sufficient data stream integrity to see run time data correctly. The thermostats do not buffer run history, so runs while off-line would be missed. Test sets with a higher connectivity percentage reduced the sample size but yielded comparable results. In instances with missing data, run length was truncated to 15 minutes.

Sensi thermostats do not report runtime data. They report condition on a periodic basis as well as change of state. This data stream is analyzed to compute run times.

The study included units indicated as multi-stage as that is the thermostat default setting and most indicating two stages are not. This provided a larger sample and had a less than 1% effect on the result.

Improperly operating or significantly undersized equipment that is unable to satisfy the load may not significantly benefit from setbacks. However, savings may still be obtained from scheduling.

The evaluation used approximately 16,000 thermostats. Test studies of random subsets of the study population did not yield materially different results validating that this data set is sufficiently large.

Comparable results were obtained from an independent evaluation for ENERGY STAR certification where run times were compared to a mathematical model home and climate data. That evaluation used a smaller data set of 1,000 thermostats.

Although an individual's run times may be significantly different from the average or median, the effect of setback should still be obtained.

DATA COMPARISON

Data sets were selected based on the magnitude and frequency of thermostat setpoint changes. Looking for activity that appeared to be regularly scheduled changes versus dithering the setpoint. Source of change was not known or considered. Scheduling, geofencing and manual adjustments were equally considered if they were regular and of sufficient magnitude.

Heat and cool setbacks were only accumulated when the thermostat was in that mode.

Although location in the building was not considered in this study, we do know some thermostats are in kitchens, locker rooms, outdoor connected spaces, loading docks, etc. In this study, those units contribute to the noise. This, of course, results in a data set with significant "tails", i.e. a considerable portion of the population well away from the median. This was present in both the setback and non-setback sets.

EQUIPMENT TYPE: Heat pumps and two stage equipment

Neither heat pumps or two stage equipment were excluded. Although a thermostat may be configured
for these systems, the equipment may be single stage standard equipment. Two stage configuration
is the factory default, as this will not negatively impact operation on a single stage system.

Two stage and heat pump systems will, by design, demonstrate longer run times than single stage systems.

A test excluding those thermostats indicated that a two stage configuration had a
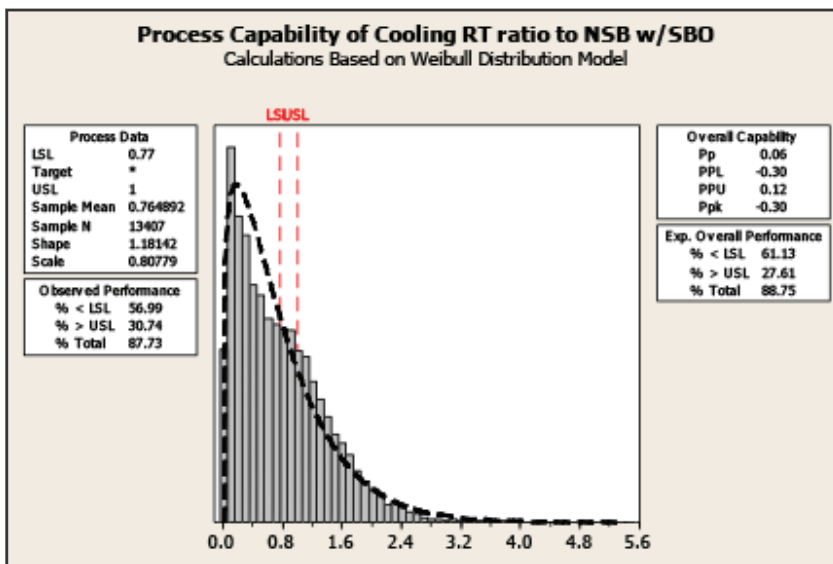very small effect supporting the failure to configure supposition.
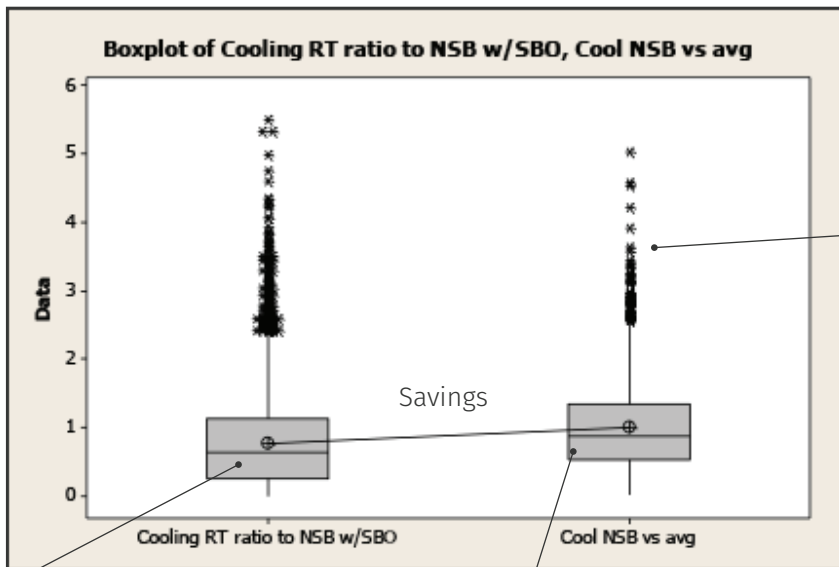
Tails represent:
· Ineffective equipment
· Undersized equipment
· Actual two stage equipment
· Heat pump

Savings

Ratio of runtime to average
runtime for setback users.

Runtimes for non-setback users

The data set is as would be expected not "normal" i.e. not Gaussian. It follows a Poisson or Weibull distribution. This shape is to be anticipated for phenomena that have a limit to one side of their response. Similar response would be demonstrated for things such as your time to drive to work as the low side is limited by the laws of physics and the speed limit. We also see similar responses for pinewood derby times – for example.

This distribution shape yields erroneous although directional results if analyzed as a normal distribution since the standard deviation will be quite large. The capability analysis above takes the distribution shape into account.

COMPARISON OF NORMAL AND WEIBULL DISTRIBUTIONS
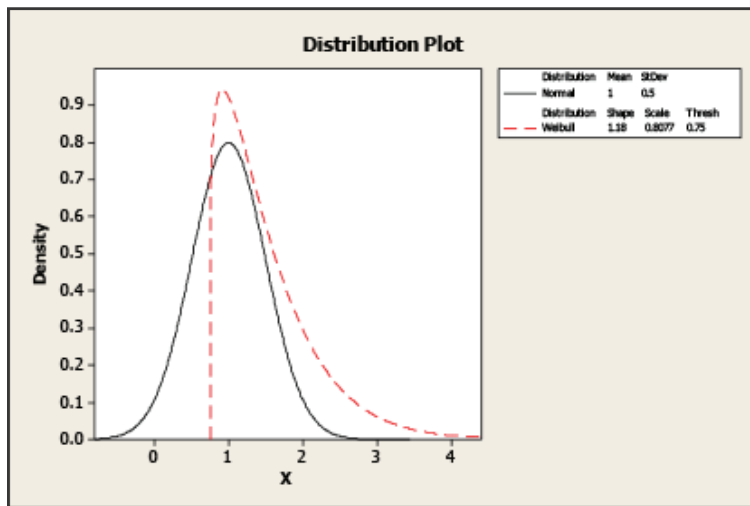
CONCLUSION

Through the analysis of real customer data, the Sensi smart thermostat saved customers about 23% on HVAC energy usage by adjusting the temperature using flexible scheduling, remote access, and geofencing[1].

Sensi does not provide any warranty or guarantee, express or implied, regarding the accuracy of any energy savings information. Thermostats sold subject to our Terms and Conditions of Sale, available at: sensicomfort. com/legal. The scope of the technical and application information is limited and is subject to updates, without notice, as we constantly evaluate and improve our technologies, and as capabilities expand.

CUSTOMER REVIEWS

"Our actual kilowatt usage dropped by 25%! Our bill was $52 less than the previous month!"
The Doctor | *5 out of 5 stars*

"...I started saving money the moment these were installed."
Adam Gold | *5 out of 5 stars*

"...I saw savings of over $100 in my energy bill
Leo | *5 out of 5 stars*

"...already seeing savings on our gas bill."
JLC | *5 out of 5 stars*

"...I also received a rebate from my local utility company"
Brandon | *5 out of 5 stars*

"I have lowered by Electricity bill by 19%"
Nick-G | *5 out of 5 stars*

1 Energy savings are calculated by comparing operation time for a nationwide sample of Sensi users with temperature adjustments averaging 4° in comparison to users with no adjustments. Savings vary based on equipment type/condition, insulation, climate & temperature adjustment size/frequency.