



ENERGY STAR® Smart Home Energy Management Systems (SHEMS)

Method to Determine Field Performance

1) OVERVIEW

This method shall be used to determine the performance of SHEMS in the field. Performance in this case is the ability to identify and react to hours that the home is vacant in order to reduce home energy use. In addition to laying out data elements required to assess performance, this method addresses optional data fields that support the Environmental Protection Agency's efforts to determine key variables relevant to establishing an energy savings metric for SHEMS, as well as information important to monitoring the evolution of the SHEMS market.

2) APPLICABILITY

This ENERGY STAR Method is applicable to SHEMS Products as defined in the ENERGY STAR Eligibility Criteria for Smart Home Energy Management Systems.

3) DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the ENERGY STAR Eligibility Criteria for Smart Home Energy Management Systems.

Away Time: A period of time during which the system uses any type of occupancy trigger to take at least one energy saving action for a space (room, floor, zone, or entire dwelling) within the home.

Population for Analysis: The population to be analyzed shall include all installations using an ENERGY STAR certified SHEMS package from a given service provider during the Period of Analysis in the United States. While each brand owner partner is ultimately responsible for demonstrating compliance with ENERGY STAR performance requirements, data may be submitted on behalf of a brand owner by their service provider. Ideally, all installations using the same original service provider's service algorithms, under any service brand name, would be analyzed together. That means that if a service provider markets their package directly to consumers under their own brand name, and also provides energy management packages on behalf of other consumer service brands, all of the installations should be analyzed together, if possible.

Period of Analysis: The time period analyzed to produce the data in the reporting template.

Mean: The arithmetic average of all values calculated per Equation 1 as the sum of all values divided by the number of values.

Equation 1: Calculation of the mean (μ)

$$\mu = \frac{1}{n} \sum_{i=1}^n x_i \text{ where } n \text{ is the number of values } (x_i)$$

Standard Error of the Mean: Assuming that the values are distributed normally, the standard error calculated per Equation 2 expresses the range that the mean is 63% likely to fall within, given the variations of data in the data set.

Equation 2: Calculation of the standard error of the mean (s_x)

$$s_x = \frac{s}{\sqrt{n}} = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n(n-1)}} \text{ where } s \text{ is the sample standard deviation.}$$

Quartiles: Expressing the distribution of values within the data set. The first quartile (Q1 or 25th percentile) is the value such that one quarter of values in the data set are at or below the value. The second quartile (Q2, median, or 50th percentile) is the value such that half of the values in the data set are at or below the value. The third quartile (Q3 or 75th percentile) is the value such that three quarters of the values in the data set are at or below the value.

4) DEMONSTRATING FIELD PERFORMANCE

Field performance of SHERMS package shall be assessed for initial certification as well as for periodic reporting as detailed in the Partner Commitments section of the ENERGY STAR Program Requirements for SHERMS.

1. The population for analysis shall include at least 50 installations, at least 30 of which meet requirement 4) 5.c.ii below.
2. For the population, calculate the required statistics and enter them into the SHERMS Data Reporting Template. The current version of the template is [available](#) as a protected Excel workbook. Appendix A explains each data element in the template in detail.
3. Precision and rounding for calculated values: precisions listed in the data template refer to the precision of the required statistics. The recorded precision of the data used to calculate the required statistics should be preserved throughout the calculation.
4. Appendix A, Section 2) is required; Sections 3) and 4) are optional.

Note: The data elements included in optional Sections 3) and 4) of Appendix A, while not required, are central to EPA's long-term efforts to support and recognize the development of SHERMS capable of seamlessly integrating energy savings and grid services while delivering additional user convenience and benefits. The data elements in Section 4) are of particular interest to stakeholders eager to see progress towards the vision of SHERMS that provide comprehensive, integrated energy management. EPA would greatly appreciate partners' cooperation in submitting these data.

5. Period of Analysis and Data Submission Guidelines
 - a. The statistics calculated and submitted in the SHERMS Data Reporting Template will be derived from analysis of a six-month period.
 - b. The end of the period of analysis shall be no more than three months before the submission date.
 - c. To be included in the sample for analysis, installations must
 - i. Have been connected to the service at the beginning and end of the period of analysis, and
 - ii. Have been connected to the service and collecting subject data for at least 90% of days in the reporting period.
6. The SHERMS Data Reporting Template shall be filled in (consistent with 2. above) and submitted:
 - a. to the Certification Body for initial certification, or
 - b. to EPA (via SmartHomeSystems@energystar.gov) for ongoing reporting.

Note: For initial certification, the population for analysis may be a pre-market test group, as long as the group meets all requirements of the population for analysis, and the service and devices used by the test group are functionally equivalent to those of the certified package. For instance, platform capabilities not bearing directly on occupancy-based savings, while they must be present at the time of certification, need not be active in the population for which analysis is submitted for initial certification.

Appendix A: Detailed description of data elements in the reporting template

1) INTERPRETATION OF STATISTICAL INFORMATION:

The definitions below contain descriptions of each data element. In cases where we ask for statistical results (mean, standard error of the mean, quantiles) the data element will describe the data for each installation, which would then be averaged over the population in question. For instance, to calculate values for “Change in number of connected devices per installation,” start with the change in number of devices visible to the platform in each installation, then calculate statistics describing the distribution of that number across installations in the population.

2) PROGRAM PERFORMANCE

- a) Total installations served by the platform: The total number of installations the platform is serving, both with and without the energy management package. Do not include installations signed up only for limited time trials. This data element characterizes a population other than that defined in Section 3.
- b) Total installations in the Population: the total number of installations in the population for analysis (see Section 3) Definitions above).
- c) Installations with insufficient data: the total number of installations in the populations for analysis that meet requirement 4)5.c.i but do not meet 4)5.c.ii.
- d) New installations registered during the reporting period: the percentage of installations in the population which first configured and registered a SHEMS in the data reporting period. Do not include installations that were first registered in a previous reporting period but experienced a lapse in service and have re-registered.
- e) Number of ENERGY STAR Certified thermostats per installation: the number of ENERGY STAR certified thermostats connected to the SHEMS in each installation in the population. EPA’s API for certified thermostats may be leveraged for verifying certification of models.
- f) Number of controllable lighting devices per installation: the number of controllable lighting devices in each installation in the population.
- g) Number of controllable lighting devices that are ENERGY STAR certified per installation: the number of controllable lighting devices that are ENERGY STAR certified in each installation in the population.
- h) Number of smart outlets per installation: the number of smart outlets in each installation in the population.
- i) Number of smart power strips per installation: the number of smart power strips in each installation in the population.
- j) Average scheduled away time per week per installation: the number of scheduled away hours per week for each installation in the population, averaged over the current reporting period, i.e. total scheduled away hours in the reporting period divided by number of weeks in the reporting period.
- k) Average non-scheduled explicitly generated away time per week per installation: the non-scheduled hard trigger away hours per week for each installation in the population, averaged over the current reporting period.
- l) Average implicitly generated away time per week per installation: the number of away hours generated implicitly by the system per week for each installation in the population, averaged over the current reporting period.
- m) Average suggested away time per week per installation: the number of away hours per week initiated by the system after the user confirms a suggested action for each installation in the population, averaged over the current reporting period.
- n) Average on time per light fixture: the average time light fixtures or control devices are on per day, averaged across all controlled lighting in each installation in the population. If providers

have data, they may weight on time by estimated relative energy consumption, e.g. a light on at 50% power for 10 minutes would count as five minutes.

- o) Average lighting load in vacation or night time safety mode per installation: the average lighting load (kWh/day) in each installation during the times the installation is in the vacation and/or night time safety mode, as required in the specification section 4.1G. Calculate by summing lighting energy used while in these modes, as reported by the lighting device(s) in use and dividing by the number of days in this mode. Number of days need not be a whole number.
- p) Installations in each of 5 climate zones: the percentage of total installations in the population located in each climate zone according to [this mapping of zip codes](#) to the Energy Information Administration (EIA) climate zones.
- q) Average weekly away hours per installation for each month in the reporting period: the average away hours of all types per installation averaged individually for each month in the reporting period, normalized to weekly hours. i.e. total away hours (sum of 6a – 6d) times 7 divided by the number of days in the month.

3) SAVINGS METRIC DEVELOPMENT (optional)

- a) Length of time subscribed: the length of time each installation in the population was continuously subscribed to the SHEMS service as of the last day of the reporting period. Statistics regarding the length of time subscribed shall be reported in days. As noted in the definition of the test population, any installation which is inactive for more than 18 days (10% of the period of analysis) is considered unsubscribed and shall not be included in the test population.
- b) Change in number of devices connected to the system in the past 6 months: for each installation in the population, calculate the net change in the number of devices connected to the system over the past 6 months as an integer (may be positive or negative). Report the quartiles, mean, and standard error of that distribution of integer values.
- c) Percent of controllable lighting devices which are scheduled or automated per installation: the percentage of controllable lighting devices which are scheduled or automated in each installation in the test population.
- d) Installations with insight into whole home energy use: the percentage of total installations in the population with the capability of estimating and reporting the energy use of the entire home, by any means. For instance, some installations may include connection to a smart meter, an optical meter reader, or a home energy submetering system, and some platforms may be able to access [Green Button](#) data for those homes that have it available.
- e) Average power during non-away time: the total average power of all power-reporting devices controlled by the system for each installation in the population during times that are not identified as “away times”, averaged over the current reporting period.
- f) Average relative reduction in power during away time: the total average power of all power-reporting devices controlled by the system during away time, averaged over the current reporting period, divided by the average power over the current reporting period during non-away time for each installation in the population.
- g) Number of thermostats per installation: the number of thermostats connected to the SHEMS platform in each installation in the population, whether they are ENERGY STAR certified or not. This is not intended to include other thermostats in the home (smart or not) that the SHEMS is unable to control or get data from.
- h) Whole installation standby power: the total standby or idle power of all devices in each installation in the population, reported in watts. The idle power of each device may be reported by the device, determined by analyzing reported device power, or assigned based on data reported for the device by the manufacturer, for instance in product literature. If no such data are available for a device, service providers may use a conservative assumed value.

4) SHEMS MARKET EVOLUTION (optional)

- a) Percent of controllable lighting devices reporting energy or power per installation: the percentage of controllable lighting devices that report energy or power data in each installation in the population.
- b) Percent of smart outlets or strips reporting energy or power per installation: the percentage of outlets and power strips reporting power or energy data in each installation in the population.
- c) Percent of installations enrolled in DR programs using SHEMS service: the percent of total installations in the test population enrolled in a load control program with a utility via the SHEMS.
- d) Installations leveraging time of use pricing: the percent of total installations in which the SHEMS algorithm optimizes energy use based on a time of use pricing structure.
- e) Percent of DR events opted-out or overridden per installation: the percentage of utility DR events which were opted-out or overridden in the data reporting period for each installation in the test population.
- f) Installations including a connected water heater or water heater controller: the percentage of total installations in which either a connected water heater or water heater controller is in communication with the SHEMS.
- g) Installations including connected PV: the percentage of total installations in which the home is equipped with solar photovoltaic panels and the solar meter output is communicated with the SHEMS.
- h) Installations including connected battery storage: the percentage of total installations in which the home is equipped with battery storage equipment connected to the SHEMS.
- i) Installations including a connected EV charger: the percentage of total installations in which the home is equipped with an electric vehicle charger connected to the SHEMS.
- j) Installations including at least one connected room air conditioner: the percentage of total installations in which the SHEMS is connected to a room air conditioner.
- k) Installations with leak detection for water heater: the percentage of total installations in which the SHEMS is capable of detecting and reporting water heater leakage.
- l) Number of installations in each of 50 States: the total number of installations in the population for analysis in each state listed.