



ENERGY STAR® Smart Home Energy Management Systems (SHEMS)

Draft Method to Determine Field Performance

6 1) OVERVIEW

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

13 **Note:** This document serves a similar purpose to that served by a test method for typical ENERGY STAR
14 products. In Version 1.0, EPA is proposing that certification be based on a demonstration of the system's
15 occupancy-based optimization performance, as a step towards building a metric that differentiates
16 SHEMS packages based on energy savings.

17 This draft, and the associated data reporting template, continue the conversation with stakeholders about
18 what data is available to be reported and what might be important to know. We look forward to a robust
19 and detailed conversation as we continue to refine the Method, which is expected to evolve independently
20 of the Version 1.0 specification and will be revised as needed.

21 2) APPLICABILITY

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

24 3) DEFINITIONS

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

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

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

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

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

41 **Equation 1:** Calculation of the mean (μ)

42
$$\mu = \frac{1}{n} \sum_{i=1}^n x_i \text{ where } n \text{ is the number of values } (x_i)$$

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

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

47
$$s_x = \frac{s}{\sqrt{n}} = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n(n-1)}}$$
 where s is the sample standard deviation.

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

53 **Note:** EPA has added a definition of Away Time in order to clearly identify hours which should be
54 categorized and reported as "away hours."

55 **4) DEMONSTRATING FIELD PERFORMANCE**

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

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

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

- 75 5. Period of Analysis and Data Submission Guidelines
 - 76 a. The statistics calculated and submitted in the SHEMS Data Reporting Template will be
77 derived from analysis of a six-month period.
 - 78 b. The end of the period of analysis shall be no more than three months before the
79 submission date.
 - 80 c. To be included in the sample for analysis, installations must
 - 81 i. Have been connected to the service at the beginning and end of the period of
82 analysis, and
 - 83 ii. Have been connected to the service and collecting subject data for at least 90%
84 of days in the reporting period.

- 85 6. The SHEMS Data Reporting Template shall be filled in (consistent with 2. above) and submitted:
86 a. to the Certification Body for initial certification, or
87 b. to EPA (via SmartHomeSystems@energystar.gov) for ongoing reporting.

88 *Note: For initial certification, the population for analysis may be a pre-market test group, as long*
89 *as the group meets all requirements of the population for analysis, and the service and devices*
90 *used by the test group are functionally equivalent to those of the certified package.*

91 **Note:** EPA has clarified the precision required for all data.

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

93 **1) INTERPRETATION OF STATISTICAL INFORMATION:**

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

100 **2) PROGRAM PERFORMANCE**

- 101 a) Total installations served by the platform: The total number of installations the platform is
102 serving, both with and without the energy management package. Do not include installations
103 signed up only for limited time trials. This data element characterizes a population other than
104 that defined in Section 3.
- 105 b) Total installations in the Population: the total number of installations in the population for
106 analysis (see Section 3) Definitions above).
- 107 c) Installations with insufficient data: the total number of installations in the populations for
108 analysis that meet requirement 4)4.c.i but do not meet 4)4.c.ii.
- 109 d) New installations registered during the reporting period: the percentage of installations in the
110 population which first configured and registered a SHEMS in the data reporting period. Do not
111 include installations that were first registered in a previous reporting period but experienced a
112 lapse in service and have re-registered.
- 113 e) Number of ENERGY STAR Certified thermostats per installation: the number of ENERGY
114 STAR certified thermostats connected to the SHEMS in each installation in the population.
115 EPA’s API for certified thermostats may be leveraged for verifying certification of models.
- 116 f) Number of controllable lighting devices per installation: the number of controllable lighting
117 devices in each installation in the population,
- 118 g) Number of controllable lighting devices that are ENERGY STAR certified per installation: the
119 number of controllable lighting devices that are ENERGY STAR certified in each installation
120 in the population.
- 121 h) Number of smart outlets per installation: the number of smart outlets in each installation in the
122 population.
- 123 i) Number of smart power strips per installation: the number of smart power strips in each
124 installation in the population.
- 125 j) Average scheduled away time per week per installation: the number of scheduled away hours
126 per week for each installation in the population, averaged over the current reporting period,
127 i.e. total scheduled away hours in the reporting period divided by number of weeks in the
128 reporting period.
- 129 k) Average non-scheduled explicitly generated away time per week per installation: the non-
130 scheduled hard trigger away hours per week for each installation in the population, averaged
131 over the current reporting period.
- 132 l) Average implicitly generated away time per week per installation: the number of away hours
133 generated implicitly by the system per week for each installation in the population, averaged
134 over the current reporting period.
- 135 m) Average suggested away time per week per installation: the number of away hours per week
136 initiated by the system after the user confirms a suggested action for each installation in the
137 population, averaged over the current reporting period.
- 138 n) Average on time per light fixture: the average time light fixtures or control devices are on per
139 day, averaged across all controlled lighting in each installation in the population. If providers

- 140 have data, they may weight on time by estimated relative energy consumption, e.g. a light on
141 at 50% power for 10 minutes would count as five minutes.
- 142 o) Average lighting load in vacation or night time safety mode per installation: the average
143 lighting load (kWh/day) in each installation during the times the installation is in the vacation
144 and/or night time safety mode, as required in the specification section 4.1G. Calculate by
145 summing lighting energy used while in these modes, as reported by the lighting device(s) in
146 use and dividing by the number of days in this mode. Number of days need not be a whole
147 number.
 - 148 p) Installations in each of 5 climate zones: the percentage of total installations in the population
149 located in each climate zone according to [this mapping of zip codes](#) to the Energy
150 Information Administration (EIA) climate zones.
 - 151 q) Average weekly away hours per installation for each month in the reporting period: the
152 average away hours of all types per installation averaged individually for each month in the
153 reporting period, normalized to weekly hours. i.e. for a 28-day month it would be total away
154 hours (sum of 6a – 6d) divided by 4; for a 31-day month, the sum of 6a – 6d times 7 over 31.

155 3) SAVINGS METRIC DEVELOPMENT (optional)

- 156 a) Length of time subscribed: the length of time each installation in the population was
157 continuously subscribed to the SHEMS service as of the last day of the reporting period.
158 Statistics regarding the length of time subscribed shall be reported in days. As noted in the
159 definition of the test population, any installation which is inactive for more than 18 days (10%
160 of the period of analysis) is considered unsubscribed and shall not be included in the test
161 population.
- 162 b) Change in number of devices connected to the system in the past calendar year: for each
163 installation in the population, calculate the net change in the number of devices connected to
164 the system over the past calendar year as an integer (may be positive or negative). Report
165 the quartiles, mean, and standard error of that distribution of integer values.
- 166 c) Percent of controllable lighting devices which are scheduled or automated per installation: the
167 percentage of controllable lighting devices which are scheduled or automated in each
168 installation in the test population.
- 169 d) Installations with insight into whole home energy use: the percentage of total installations in
170 the population with the capability of estimating and reporting the energy use of the entire
171 home, by any means. For instance, some installations may include connection to a smart
172 meter, an optical meter reader, or a home energy submetering system, and some platforms
173 may be able to access [Green Button](#) data for those homes that have it available.
- 174 e) Average power during non-away time: the total average power of all power-reporting devices
175 controlled by the system for each installation in the population during times that are not
176 identified as “away times”, averaged over the current reporting period.
- 177 f) Average relative reduction in power during away time: the total average power of all power-
178 reporting devices controlled by the system during away time, averaged over the current
179 reporting period, divided by the average power over the current reporting period during non-
180 away time for each installation in the population.

181 **Note:** EPA has included two new optional data fields, average power during non-away time and
182 average power reduction during away time, in response to stakeholder comments that such
183 information would be highly informative when assessing the energy savings achieved by SHEMS.
184 EPA agrees that this information could be very valuable, though it would be expected to significantly
185 under-report savings, as it won't include the power of all elements of the systems that are optimized,
186 most notably the heating and cooling energy controlled by the thermostat. This could be mitigated by
187 asking for whole home power (from systems with such access) during away and non-away times, but

188 the relatively small power savings signal would likely be invisible compared to the much larger
189 variations in whole home power from factors outside of the SHEMS control, such as weather.

- 190 g) Number of thermostats per installation: the number of thermostats connected to the SHEMS
191 platform in each installation in the population, whether they are ENERGY STAR certified or
192 not. This is not intended to include other thermostats in the home (smart or not) that the
193 SHEMS is unable to control or get data from.
- 194 h) Whole installation standby power: the total standby or idle power of all devices in each
195 installation in the population, reported in watts. The idle power of each device may be
196 reported by the device, determined by analyzing reported device power, or assigned based
197 on data reported for the device by the manufacturer, for instance in product literature. If no
198 such data are available for a device, service providers may use a conservative assumed
199 value.

200 **4) SHEMS MARKET EVOLUTION (optional)**

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

230 **Note:** In response to a stakeholder comment, EPA has added the optional field in which service
231 providers may report the total number of SHEMS installations in each state. This information, which
232 would be released in aggregate for the entire program, is expected to provide value for state officials,
233 particularly utility regulators, that are considering utility rate structures, as it indicates the number of
234 homes in their state with systems capable of time of use integration.