



ENERGY STAR® Smart Home Energy Management Systems (SHEMS)

Draft 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.

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

This draft, and the associated data reporting template, are intended to be the beginning of a conversation with stakeholders about what data is available to be reported and what might be important to know. We look forward to a robust and detailed conversation as we continue to refine the Method.

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.

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. 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.

Note: Ideally, the population to be analyzed would include all installations that have energy management provided by the same underlying set of algorithms. EPA is aware that there is broad scope for customization from installation to installation, and potentially from a single service provider, and welcomes feedback about whether the population definition above will accomplish our aims.

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.

43

Equation 1: Calculation of the mean (μ)

44

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

45

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.

46

47

48

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

49

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

50

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.

51

52

53

54

55

4) DEMONSTRATING FIELD PERFORMANCE

56

Field performance of SHEMS 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 SHEMS.

57

58

59

1. For the population, calculate the required statistics and enter them into the SHEMS 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.

60

61

62

2. Appendix A, Section 2) is required; Sections 3) and 4) are optional.

63

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 SHEMS 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 SHEMS systems that provide comprehensive, integrated energy management. EPA would greatly appreciate partners' cooperation in submitting these data.

64

65

66

67

68

69

70

3. Period of Analysis and Data Submission Guidelines

71

a. The statistics calculated and submitted in the SHEMS Data Reporting Template will be derived from analysis of a six-month period.

72

73

b. The end of the period of analysis shall be no more than three months before the submission date.

74

75

c. To be included in the sample for analysis, installations must

76

i. Have been enrolled for the service at the beginning and end of the period of analysis, and

77

78

ii. Have been connected to the service and collecting subject data for at least 90% of days in the reporting period.

79

80

4. The SHEMS Data Reporting Template shall be filled in (consistent with 2. above) and submitted:

81

a. to the Certification Body for initial certification, or

82

b. to EPA (via SmartHomeSystems@energystar.gov) for ongoing reporting.

83 **Note:** EPA has included a draft of the reporting template with this draft Method. EPA seeks stakeholder
84 feedback about whether the protected Excel format is the only one needed for use. Note boxes in
85 Appendix A discuss the reasons to include many of the data elements and ask for specific feedback
86 about many of them.

87 EPA believes that data collected over six months will provide sufficient detail to determine product
88 performance. Unlike for thermostats, EPA does not expect strong seasonal effects on savings, though
89 vacations may have a significant impact.

90 As noted in the data template header, partners will be able to submit data such that EPA sees only
91 anonymized information, to avoid holding sensitive business information.

92 The ENERGY STAR Method to Demonstrate Connected Thermostat Field Savings includes substantial
93 data retention requirements. Such requirements make it easier to audit partners to check that their data
94 reporting is both competent and honest. EPA does not anticipate a data retention requirement in this first
95 version of the Method for SHEMS but is likely to include something similar in future versions.

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

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

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

104 **Note:** The data described here are those that characterize field performance, rather than the properties of
105 the package to be displayed on a list of certified packages. However, some of these data are likely to be
106 of interest to those using our list of certified packages, as noted below. EPA encourages stakeholder
107 feedback about any other elements that would be of interest, and about whether the ones noted here
108 would be impossible to share without business concerns. In that case, it would also be useful to know of
109 other information that might be more palatable to share and give similar insight.

110 **2) PROGRAM PERFORMANCE**

- 111 a) Total installations served by the platform: The total number of installations the platform is
112 serving, both with and without the energy management package. Do not include installations
113 signed up only for limited time trials. This data element characterizes a population other than
114 that defined in Section 3.
- 115 b) Total installations in the Population: the total number of installations in the population for
116 analysis (see Section 3) Definitions above).
- 117 c) New installations registered during the reporting period: the percentage of installations in the
118 population which first configured and registered a SHEMS in the data reporting period. Do not
119 include installations that were first registered in a previous reporting period but experienced a
120 lapse in service and have re-registered.
- 121 d) Number of ENERGY STAR Certified thermostats per installation: the number of ENERGY
122 STAR certified thermostats connected to the SHEMS in each installation in the population.
123 EPA’s API for certified thermostats may be leveraged for verifying certification of models.
- 124 e) Number of controllable lighting devices per installation: the number of controllable lighting
125 devices in each installation in the population,
- 126 f) Number of controllable lighting devices that are ENERGY STAR certified per installation: the
127 number of controllable lighting devices that are ENERGY STAR certified in each installation
128 in the population.
- 129 g) Number of smart outlets per installation: the number of smart outlets in each installation in the
130 population.
- 131 h) Number of smart power strips per installation: the number of smart power strips in each
132 installation in the population.
- 133 i) Average scheduled away hours per week per installation: the number of scheduled away
134 hours per week for each installation in the population, averaged over the current reporting
135 period, i.e. total scheduled away hours in the reporting period divided by number of weeks in
136 the reporting period.
- 137 j) Average non-scheduled explicitly generated away hours per week per installation: the non-
138 scheduled hard trigger away hours per week for each installation in the population, averaged
139 over the current reporting period.
- 140 k) Average implicitly generated away hours per week per installation: the number of away hours
141 generated implicitly by the service per week for each installation in the population, averaged
142 over the current reporting period.

- 143 l) Average suggested away hours per week per installation: the number of away hours per
144 week initiated by the service after the user confirms a suggested action for each installation in
145 the population, averaged over the current reporting period.
- 146 m) Average on time per light fixture: the average time light fixtures or control devices are on per
147 day, averaged across all controlled lighting in each installation in the population. If providers
148 have data, they may weight on time by estimated relative energy consumption, e.g. a light on
149 at 50% power for 10 minutes would count as five minutes.
- 150 n) Whole system standby power: the total standby or idle power of all devices in each
151 installation in the population, reported in watts.

152 **Note:** EPA has specific goals in asking for each data element in the field data collection. We welcome
153 comments about the practicality of collecting this data, and suggestions about data that are easier to
154 collect and would serve the same purpose.

155 Elements in this section will check package compliance with specification requirements and/or bear
156 directly on expected savings and program savings. Elements 2a – 2c indicate how much of the market is
157 using ENERGY STAR SHERMS. Stakeholders let us know that many households invest in a limited time
158 trial without signing up permanently and ask that those installations not be included in the count of total
159 installations. We welcome stakeholder feedback about clearer, easier measures of this, e.g. installations
160 that were signed up for more than one month. Elements 2d – 2h bear directly on specification
161 requirements. EPA anticipates that accounting for the number of ENERGY STAR certified thermostats
162 and lighting devices will require tracking the make and model of each connected device but
163 acknowledges that there may be other methods. EPA encourages feedback regarding this data
164 requirement.

165 EPA deems data elements 2i – 2l most likely to distinguish installations and platforms that save the most
166 energy, based on our hypothesis that the lowest hanging fruit for smart home energy savings is to reduce
167 household energy use when the home is empty. While we have tried to be clear about these different
168 kinds of away hours in the definitions in the specification, EPA is aware that these categories do not cover
169 all energy saving actions based on occupancy, and that different service providers may distinguish these
170 differently. EPA hopes that with stakeholder involvement we will develop practices with clear definitions
171 and metrics that can distinguish platforms that provide significant savings.

172 Element 2m will allow comparison to existing average lighting on time estimates for the general
173 population. EPA's goal in asking for element 2n is to demonstrate that the estimated savings from
174 SHERMS installations is larger than the estimated additional load for connectivity. We imagine that the
175 estimate could come from a variety of data including, for instance, spec sheets of connected devices.
176 EPA is aware that it may be difficult for service providers to measure and report the whole system
177 standby power of an installation and welcomes feedback regarding alternate measures which could help
178 estimate the standby power of connected devices.

179 **3) SAVINGS METRIC DEVELOPMENT (optional)**

- 180 a) Length of time subscribed: the length of time each installation in the population was
181 continuously subscribed to the SHERMS service as of the last day of the reporting period.
182 Statistics regarding the length of time subscribed shall be reported in days. As noted in the
183 definition of the test population, any installation which is inactive for more than 18 days (10%
184 of the period of analysis) is considered unsubscribed and shall not be included in the test
185 population.
- 186 b) Change in number of devices connected to the system in the past calendar year: for each
187 installation in the population, calculate the net change in the number of devices connected to
188 the system over the past calendar year as an integer (may be positive or negative). Report
189 the quartiles, mean, and standard error of that distribution of integer values.
- 190 c) Installations in each of 5 climate zones: the percentage of total installations in the population
191 located in each climate zone according to [this mapping of zip codes](#) to the Energy
192 Information Administration (EIA) climate zones.

- 193 d) Average weekly away hours per installation for each month in the reporting period: the
194 average away hours of all types per installation averaged individually for each month in the
195 reporting period, normalized to weekly hours. i.e. for a 28-day month it would be total away
196 hours (sum of 6a – 6d) divided by 4; for a 31-day month, the sum of 6a – 6d times 7 over 31.
197 e) Percent of controllable lighting devices which are scheduled or automated per installation: the
198 percentage of controllable lighting devices which are scheduled or automated in each
199 installation in the test population.
200 f) Installations with insight into whole home energy use: the percentage of total installations in
201 the population with the capability of estimating and reporting the energy use of the entire
202 home, by any means. For instance, some installations may include connection to a smart
203 meter, an optical meter reader, or a home energy submetering system, and some platforms
204 may be able to access [Green Button](#) data for those homes that have it available.
205 g) Number of thermostats per installation: the number of thermostats connected to the SHEMS
206 platform in each installation in the population, whether they are ENERGY STAR certified or
207 not. This is not intended to include other thermostats in the home (smart or not) that the
208 SHEMS is unable to control or get data from.

209 **Note:** EPA is encouraging the submittal of data elements in this section to allow us to interpret the “away
210 hours” results collected in the previous section, and to check on properties that we think may affect the
211 extent to which they are triggered, so that we can understand how to account for them in an eventual
212 metric. Some also have a bearing on the potential savings in installations, which may also be important to
213 developing a metric.

214 Elements 3a and 3b will serve as a check on whether length of time subscribed affects average away
215 hours, and whether differences between vendors could be explained by this effect, rather than by the
216 algorithms themselves.

217 Elements 3c and 3d: Providers with strongly localized installations are likely to have different savings
218 opportunities available to them, which should be accounted for to understand differentiation. Similarly, the
219 extent to which away hours are triggered may depend on seasonality, and EPA may need to take this into
220 account to compare vendors fairly when developing a metric.

221 Element 3e helps characterize the “depth” of away hours and may be important to setting a metric.
222 Elements 3f and 3g are an effort to further characterize potential factors affecting savings.

223 A note about all the lighting data elements: Ideally, EPA would like to know about total lighting load, rather
224 than number of lights or lighting control devices, reflecting the fact that the load controlled by a particular
225 connected light will vary highly, from a single 5W LED bulb to potentially a 150W sun lamp for a pet lizard.
226 Clearly, the value of controlling such loads will be different. However, we also are aware that service
227 providers may not have this information for all the lighting loads connected to the platform. Thus, we are
228 asking largely about lighting and lighting control devices.

229 Other information we thought likely relevant to the efficacy of a particular SHEMS package is whether the
230 system was installed when the home was originally built, and how many occupants are in the home.
231 However, as far as we know, service providers have incomplete and unreliable access to this data. EPA
232 welcomes comments on whether these properties are likely to affect performance, and if so, whether
233 there are data that would help shed light on them and are practical to collect. EPA is also interested in
234 how common it is for SHEMS installations to include a single thermostat that controls multiple zones but
235 is unsure if platforms will be capable of recording the information, and therefore did not include it as a
236 data element. EPA is interested in feedback about the situations in which it is possible for the platform to
237 have this information.

238 EPA also wonders whether use of voice control to trigger energy saving actions is related to performance.
239 If we asked for the total number of hours triggered by voice control (a subset of explicitly triggered
240 actions), would service providers be able to collect that data? Alternately, we could ask for the percent of
241 installations that have voice control enabled, which would be less specific but easier for service providers
242 to track. EPA would welcome feedback on these points.

243

4) SHEMS MARKET EVOLUTION (optional)

244

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.

245

246

247

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.

248

249

250

251

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.

252

253

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.

254

255

256

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.

257

258

259

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.

260

261

262

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.

263

264

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.

265

266

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.

267

268

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.

269

270

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.

271

272

273

274

Note: During the fall, EPA invited stakeholders to participate in work groups (four in all) that examined several specific topics to clarify our thinking in preparation for this Draft specification. A vision of the eventual fully integrated smart home emerged from these discussions. Elements in this section reflect measures of progress towards that vision, a topic of keen interest to many SHEMS stakeholders.

275

276

Elements 4a and 4b address comprehensive energy reporting, which was part of that vision and was identified as a key building block by the DR/DER work group.

277

278

279

Data elements 4c – 4j address the prevalence of SHEMS' use to balance consumer needs and grid conditions, indicating progress towards stakeholders' shared vision of integrated demand side management.

280

281

Element 4k addresses an important opportunity for advanced notice of failure to allow replacement with high efficiency models.

282

283

284

285

In addition, EPA is interested in understanding the loads or types of loads which are controlled by smart outlets but is aware that it may not be possible for service providers to collect reliable information about it. We welcome any suggestions for even the classification of such loads, for instance into categories such as lighting, resistance heating devices, IT and CE devices, etc.