Superior Energy Performance
Measurement and Verification Protocol for Industry

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1. Introduction

This Measurement and Verification Protocol for Industry defines the procedures that will be used to confirm conformance with the energy performance level requirements of the Superior Energy Performance (SEP) Program. The Program has two paths. This document is structured to reflect those different paths.

Requirements

The SEP program criteria for all levels require a facility to:

A. Have an energy management system that conforms to the ISO 50001: *Energy management systems-Requirements with guidance for use* (referred to as ISO 50001 in the remainder of the document), and
B. Have met program performance levels for the selected application category.
    1. For the Energy Performance Pathway, meeting the program performance level means achieving an energy performance improvement of a designated percentage (varying with the program level) over the past 3 years.
    2. For the Mature Energy Pathway, meeting the performance level means achieving designated energy performance improvements over a required period of time and demonstrating preferred practices in accordance with the SEP Industrial Facility Best Practice Scorecard.

For Requirement A, see section 2 of this document.

For Requirement B, program performance level, there are 2 pathways, the Energy Performance Pathway and the Mature Energy Pathway. Energy performance improvement is required for both pathways. Demonstrated energy performance improvement has 2 components:

1. **Top-Down**. Top-down energy performance improvement is facility-level improvement calculated from energy consumption data at the whole facility level. Conformance with the program requires that the top-down estimate must show savings better than the threshold for that performance level.

2. **Bottom-Up.** Bottom-up energy performance improvement is facility-level improvement calculated by analysis of individual changes made at the facility. This Protocol does not require detailed bottom-up analysis, but does require a high-level bottom-up “sanity check” of the top-down result. Bottom-up analysis alone cannot be used to meet the energy performance improvement requirement.

Section 3 of this document describes how energy performance is defined for SEP and how energy performance improvement can be demonstrated.

The Mature Energy Pathway additionally requires practices described in the SEP Industrial Facility Best Practice Scorecard. For Best Practice Credits based on energy performance improvement, this improvement will be calculated as described in this document.

Facilities are responsible for conducting necessary data collection, analysis, and documentation as described below, and as described in the SEP Industrial Facility Best Practice Scorecard, when applicable. Certified Partner applicants will also be responsible for providing the data, analysis methods, results, and other documentation to the SEP Audit Team. The SEP Audit Team will be responsible for reviewing the information provided and verifying that the measurement methods and results conform to this Protocol and for inspecting the facility to confirm conformance to the energy management system requirements. For example, the SEP Audit Team would confirm conformance with operational processes and practices, as well as confirming equipment and metering points.

2. Energy Management System Conformance

SEP requires conformance with ISO 50001. Additional requirements for conformance with SEP are described in ANSI/MSE 50021.

3. Verifying Energy Performance Improvement

3.1 Energy Performance Improvement Requirement

3.1.1 Required Improvement by Pathway and Level

Requirement: Demonstrate an energy performance improvement of at least the designated percentage over the previous 3 years after the baseline period (for the Energy Performance Pathway) or 10 years after the baseline period (for the Mature Energy Pathway). The table below indicates the designated percentage improvement required for each pathway and level.

Table 3-1. Minimum Energy Performance Improvement Threshold and Timeframe for Achieving for Different Pathways and Levels

		Level		
Pathway	**Requirements**	**Silver**	**Gold**	**Platinum**
Energy Performance	Minimum % improvement	5%	10%	15%
	Maximum years to achieve*	3	3	3
Mature Energy	Minimum % Improvement	15%	15%	15%
	Maximum years to achieve*	10	10	10
	Minimum Best Practice Scorecard points	35	61	81

*A reduced time frame may be justified, see section 3.5.2 for details.

3.1.2 Definition of Energy Performance Improvement

Energy consumption for purposes of the energy performance improvement calculation is the total of all energy sources entering the facility or withdrawn from facility inventory or stockpile, excluding feedstocks and excluding energy sources passed through the facility to an outside party. Fossil fuels and biomass are valued in terms of their BTU content. Electricity and other derived energy sources are valued in terms of the primary energy required to generate the energy delivered to the participating facility. The methodology for calculating the combined total of energy consumption across energy source types is given in section 3.3, and the methodology for converting delivered energy to primary energy is given in section 3.7.

Energy Performance is defined for ISO 50001 as "measurable results related to energy efficiency, use and consumption," with the following notes:

> NOTE 1 In the context of energy management systems, results can be measured against the organization's energy policy, objectives, targets and other energy performance requirements.
>
> NOTE 2 Energy performance is one component of the performance of the energy management system.

Energy performance is measured in ISO 50001 by the **Energy Performance Indicator (EnPI).** In the context of this program, the SEP energy performance indicator, **SEnPI,** is the ratio of reporting-period energy consumption to baseline consumption where one or both of these values is adjusted so that the two consumption amounts correspond to consistent conditions. Baseline consumption represents the consumption that would have occurred during the reporting period in the absence of energy performance improvements. For the calculation of the SEnPI, the reporting-period and/or baseline consumption must be adjusted so that they represent consistent production levels and other external conditions. Thus, the SEnPI is the ratio of reporting-period energy consumption to baseline-period energy consumption, where one or both of these consumption quantities are adjusted. The **energy performance improvement** is one minus this ratio (or 100% minus the ratio expressed as a percent).

Thus,

$$SEnPI = BTU^*_{RptPd}/BTU^*_{Base},$$

And

$$\text{Energy Performance Improvement} = (1\text{-}SEnPI) \times 100$$

where BTU^*_{RptPd} and BTU^*_{Base}, respectively, are reporting-period and baseline energy consumption, and one or both is adjusted so that they correspond to consistent conditions. An SEnPI less than one indicates that energy has been saved. Qualification for SEP is based on the SEnPI as defined here, not on a calculated quantity of energy saved.

Thresholds must be met by the SEnPI rounded to the first decimal point. For example, an improvement of 9.95% rounds to 10.0% (5's always rounding up) and meets a 10% improvement threshold. An improvement of 9.94% rounds to 9.9% and does not meet the 10% improvement threshold.

3.1.3 Definition of Adjustment Model Applications Methods for Calculating the SEnPI

Three primary methods are allowed for applying an adjustment model to calculate the SEnPI. A fourth application method is allowed that is a composite of two of the primary methods. For each application method, production levels and other external factors are independent variables in a model used to adjust consumption from the baseline period or the reporting period or both to common conditions. The three primary application methods are as follows:

- **Forecast:** Compare the actual reporting-period energy consumption to the adjusted baseline-period energy consumption. The adjusted baseline-period energy consumption is the estimated energy consumption that would have been expected at reporting-period production levels and external factors, if the baseline operating equipment and practices were still in place. The estimate is the result of a model of energy consumption fit to baseline period consumption data, and applied at reporting-period conditions.

- **Backcast:** Compare the adjusted reporting-period energy consumption to the actual baseline-period consumption. The adjusted reporting-period energy consumption is the estimated energy consumption that would have been expected at baseline production levels and external factors, if the reporting-period operating equipment and practices were in place. The estimate is the result of a model of energy consumption fit to reporting-period consumption data, and applied at baseline-period conditions.

- **Standard Conditions:** Compare the adjusted reporting-period consumption to the adjusted baseline-period consumption. The adjusted consumption for each period is the estimated energy consumption that would have been expected at a standard set of production levels and external factors, if the operating equipment and practices of the respective period were in place. Each estimate is the result of a model of energy consumption fit to consumption data for the period, and applied at standard conditions.

To calculate the SEP energy performance indicator (SEnPI) by any of these methods, baseline and reporting-period energy consumption must be assessed at the same production levels and the same external conditions that affect energy consumption, such as weather. As indicated above, the SEnPI is the ratio of the reporting-period to baseline consumption where one or both of these values are adjusted so that the two consumption amounts correspond to consistent conditions:

$$SEnPI = BTU^*_{RptPd}/BTU^*_{Base},$$

where BTU^*_{RptPd} and BTU^*_{Base}, respectively, are reporting-period and baseline energy consumption, normalized as required by the method. The table below indicates how these two energy values are determined for each method. Also indicated in the table is the notation used below to refer to the actual and estimated energy consumption for each method.

Table 3-2. Modeled and Actual Energy Consumption for Baseline and Reporting Periods by SEnPI Method

Energy Consumption Quantity	Adjustment Model Application Method		
	Forecast (Default)	Backcast	Standard Conditions
Reporting period energy	Actual reporting-period energy	Reporting-period model applied at baseline conditions	Reporting-period model applied at standard conditions
$BTU^{*}_{Rpt\text{-}Pd}$	$BTU_{Rpt\text{-}Pd}$	$BTU^{\wedge}_{Rpt\text{-}Pd\|Base}$	$BTU^{\wedge}_{Rpt\text{-}Pd\|Std}$
Baseline energy	Baseline model applied to reporting-period conditions	Actual baseline period energy	Baseline model applied to standard conditions
BTU^{*}_{Base}	$Btu^{\wedge}_{Base\|RptPd}$	Btu_{Base}	$Btu^{\wedge}_{Base\|Std}$

A fourth adjustment model application method is **SEnPI Chaining**. This method is a composite of the Forecast and Backcast methods. The SEnPI Chaining method is described further in section 3.6.5.

Section 3.2 describes how the adjusted consumption is established for any of the three primary adjustment model application methods. Section 3.6 describes how improvement relative to the baseline is demonstrated, depending on the adjustment model application method chosen, and the validity of the adjustment model(s).

For each of the adjustment model application methods, a model is used to project baseline-period and/or reporting-period observed consumption to a common set of conditions. The SEnPI's top-down requirement for a particular pathway and performance level is met if the Energy Performance Improvement corresponding to the SEnPI (calculated from facility-level energy data per Section 3.1.2) exceeds the threshold.

3.2 Calculating Adjusted Consumption

Calculation of the energy performance improvement by the Forecast, Backcast, or Standard Conditions application method requires a means of calculating adjusted consumption. This is the estimated consumption that would have occurred for a particular set of operating equipment and practices, at a given level of production and external conditions. That is, a model is fit to data from either the baseline or reporting period (or an intermediate period in the case of Chaining). The model is then applied at the conditions for which the energy performance is to be calculated. The data used for model fitting and evaluation for the 3 primary application methods and the composite Chaining application method are shown in Table 3-3.

Table 3-3. Data Used for Model Fit by SEnPI Adjustment Model Application Method

	Adjustment Model Application Method			
Data Used to Fit and Apply Adjustment Model	**Forecast**	**Backcast**	**Standard Conditions**	**Chaining**
Data used to fit the model (determine the coefficients)	Baseline	Reporting-period	Baseline and reporting-period (separate fits)	Intermediate or mid period
Data used to apply the model (calculate consumption using the previously determined coefficients)	Reporting-period	Baseline	Standard conditions	Reporting period and baseline period (separate applications of the model)

The following model specification forms apply for all 3 primary adjustment model application methods.

3.2.1 Fitting the Adjustment Model

Fit a model describing each energy source as a function of production levels, other key input streams, and/or weather. The data used to fit the model must cover the range of seasonal and other operating patterns that apply over the course of a year.

3.2.2 Model Forms

One of the following modeling forms may be used.

Model Form 1. Ratio of energy consumption to single production level.[1]

This is the simplest form, and corresponds to the common use of the term "energy intensity". Examples are consumption per ton or gallon of product. The ratio model takes the form

$$BTU = bx,$$

where x is a measure of the production quantity. The coefficient b is calculated from the historical data on consumption and production. This coefficient is the energy consumption per unit of production.

Use of this model form would require the ability to represent meaningfully all output in a single quantity such as total tons or gallons. However, in most cases, it is expected that the consumption depends on more than one production quantity and may also depend on additional factors including weather. In these cases, the ratio of energy consumption to simple production level would not be an acceptable model.

Model Form 2. Linear regression model.

Linear regression models allow multiple factors to be taken into account in estimating consumption. In most cases, multiple factors or at least a variable factor (x) and a constant term (b_0) are likely to be required to model consumption adequately.

[1] This could be a ratio estimator or 0-intercept simple regression estimator.

The general form is

$$BTU = b_0 + b_1x_1 + b_2x_2 + \ldots + b_kx_k.$$

The predictor variables x_1, x_2, … x_k may include terms such as

- Production quantities (e.g. tons) of different product lines
- Weather terms such as cooling degree-days
- Temperature or heat content of feedstocks

Developing the model will require statistical testing and screening to determine what terms to include. Input quantities as well as product output levels should be tested for inclusion in the model.

Model Form 3. Complex regression model

Two forms of complex regression models may be used.

a) Polynomial regression model.
This is a linear regression including terms in integer powers of the individual regression variables and products of these variables. For example, for a second-order polynomial in x_1, x_2, x_3, terms would include any or all of x_1^2, x_2^2, x_3^2, x_1x_2, x_2x_3, and x_3x_1 in addition to x_1, x_2, x_3. A second-order polynomial model can serve as an approximation to a more complicated nonlinear model.

b) General nonlinear regression model.
This form allows terms that are nonlinear in the estimated coefficients. For example, model terms could include x^β with β to be determined by the regression.

3.3 Calculations for a Facility

3.3.1 The Facility as the participating unit

The participating unit for SEP is an industrial facility. A facility may be the entire area occupied by an organization at a particular location, or may be a subset. If the participating facility is a subset of the organizational area, measured energy consumption data for each energy source must be available for the defined facility boundaries. Typically, submetering will be necessary to meet this requirement, as described further in section 3.9.

Sources together accounting for a total of up to 5 percent of the facility's total primary energy consumption can be considered negligible and therefore may be omitted from the calculation of total facility consumption. In calculating the percent of total consumption represented by excluded energy sources, both the excluded energy sources and total facility consumption must be calculated as primary energy, as described in section 3.7. The determination that omitted energy sources constitute less than 5 percent of facility primary energy consumption must be based on measured or calculated data, meeting the data quality requirements of Section 3.9.

A particular energy source must either be included in the facility total consumption in both the baseline and reporting periods, or must be excluded in both periods. To be excluded in both periods the energy source must be below the "negligible" level in each period. If the energy source for a particular use is shifted from one energy source to another over the achievement period, and either energy source is not negligible in either period, both affected energy sources must be included in both periods.

3.3.2 Totaling Facility Subsets

In most cases, for each energy source, the whole facility will be modeled in one step. An alternative is to divide the facility into subsets that are each modeled separately, and aggregate to a facility-level SEP Energy Performance Indicator (SEnPI). In particular, Modeling Form 1 in most cases would be applied for a subset consisting of a single, separately metered product line.

Separate modeling of a subset requires historical consumption data on that subset in isolation. Each part of the facility must be included in one and only one subset. The facility-level modeled consumption is then the sum of the separately modeled estimates.

As a general example, each major production line could be a separate subset. Facility support systems such as lighting and HVAC could be treated as separately modeled subsets if their energy consumption can be isolated. Alternatively, their energy consumption may be included with the various production subsets.

3.3.3 Totaling Energy Sources

Different energy sources, such as electricity, natural gas, or fuel oil ordinarily will be modeled separately. The sum of 2 or more energy sources may be summed and modeled as a single, combined source, provided:

1. The model for the combined energy sources satisfies the validity requirements described in section 3.4, and
2. Energy sources are combined as total BTU using multipliers that satisfy the following conditions for primary energy calculation:
   - Fossil fuels and biomass are counted in terms of their higher heating value BTU content (with no efficiency adjustment)
   - Electricity is converted to primary BTU, applying a multiplier that accounts for generation efficiency.
   - Other derived sources including steam, hot water, and chilled water are converted to primary Btu applying corresponding multipliers.

Total energy consumption BTU_{TOT} is thus the sum of the primary BTUs of the different energy sources. This total is calculated the same way for adjusted BTUs. The adjusted total energy is thus calculated using the following equation

$$BTU^*_{TOT} = \sum_f m_f \, BTU^*_f$$

where BTU^*_f is the adjusted BTU content of energy source f, and the multiplier m_f for energy source f is 1 for combustion fuels, and 3 for electricity in most cases as detailed in section 3.7.

The total facility energy performance indicator is calculated using the total BTU for both the baseline and reporting periods:

$$SEnPI = BTU^*_{\mathbf{TOT, RptPd}} \,\mathbf{/}\, BTU^*_{\mathbf{TOT, base}}$$

3.4 Model Validity for Calculating Adjusted Consumption

The model used to calculate adjusted consumption for the baseline or reporting period must satisfy the validity requirements described in this subsection. These requirements apply regardless of which adjustment model form (as defined in Section 3.1.3) is used. The requirements of Sections 3.4.1 through 3.4.9 apply regardless of which model form (as defined in Section 3.2.2) is used. Special requirements for validity of complex models are given in Section 3.4.10.

3.4.1 Variables Included in the Model

The model development must try to avoid both omitting important variables and including irrelevant variables.

Variables considered for inclusion in the model must include:

- Production quantities
- Weather
- Input quantities and input characteristics, such as moisture content

The specific variable definitions are left to the discretion of the participating facility. Any of these variables may be left out of the model if there is no logical mechanism by which the variable would affect consumption of the energy source, or if the variable is tested for inclusion in the model and found not to be statistically significant at the 10% significance level. That is, the variable may be excluded if its p-value is greater than 0.10).

In some cases, a group of related variables may all affect energy consumption, but if all are included in the model, none will have a sufficiently low p-value to be considered statistically significant. In such cases, it is recommended that subsets of these variables be tested for inclusion in the model; they should not all be eliminated together. For example, if 3 variables all have high p-values when all are included in the model, alternative models that include any 2 of the 3 should be tested, rather than dropping all three at once.

It is possible that consumption of a particular energy source at a facility may be independent of all variables considered, based on logic or empirical evidence from statistical tests as described here. In this case, no adjustment is required to the annual Btu for that energy source in the calculation of the SEnPI. If all energy sources consumed at the facility are independent of any other variables, no adjustment is required to any of the energy sources for calculation of the facility SEnPI. In this case, the SEnPI will be the ratio of total unadjusted reporting-period Btu to total unadjusted baseline-period Btu.

3.4.2 Time Period of Data Included in the Model

In most cases, the model must be fit using historical data spanning at least 12 months. This is to ensure that operating patterns over all seasons of the year are reflected in the model. A shorter period may be used if there is no weather sensitivity in the consumption of a particular energy source, and no other seasonal pattern in its consumption. Lack of weather sensitivity and seasonal pattern must be based on the mechanics of how the energy source is used (e.g., natural gas is not used for heating or cooling and production levels don't vary seasonally). The data used to fit the model may be at whatever frequency of observation is available from metering data for each energy source, provided the model significance testing criteria of section 3.4.5 are met. Data at a fine interval such as 15-minute or hourly may be summed or averaged to weekly or monthly, provided the model testing criteria are satisfied. Modeling of data at finer intervals than weekly requires approval by the SEP Administrator. Energy data may be at irregular intervals, for example with bulk fuels if deliveries are unequally spaced in time.

Consumption data will frequently not be available for exact calendar months. In some cases, the data available within a 12-month period may be insufficient to achieve the required model significance. For these reasons, the data used to fit the adjustment models may span more than 12 months. If the data for either the baseline or reporting period spans more than 12 months, the time from baseline to reporting period will be measured as the time from the midpoint of the baseline period to the midpoint of the reporting period.

The model(s) used to construct the SEnPI must adjust the baseline and/or reporting period consumption to a consistent time period and calendar. If both baseline and reporting period consumption are adjusted, in most cases both will be adjusted to a calendar year. If only the baseline period is adjusted, it should be adjusted to correspond to the same set of days as the reporting period, and vice versa. For example, if the reporting period data spans 13 months, the baseline data should be adjusted to represent the same 13 months.

3.4.3 Data Screening

The data must be screened for anomalous values that are not representative of typical operating conditions. If high variability is characteristic of the operation, outliers do not necessarily need to be removed. However, the effect of outliers on the reliability of the model estimates should be noted.

A particular type of "outlier" is data from shut-down periods when production is zero. If a single otherwise valid model can be fit that includes these conditions as well as more typical operating conditions, the shut-down period does not have to be eliminated. The comprehensive model can be used and applied to determine adjusted consumption for a period that includes normal operation, shut-down, or both. If a single otherwise valid model cannot be estimated, normal operations and shut-down can be treated as separate modes of operation, as described in section 3.4.9.

3.4.4 Model Form

The specified model form should be consistent with an expected relationship based on prior operating experience, or other sound basis for how each variable is expected to affect energy consumption. If a complex form is used, the rationale for the form should be given, along with statistical goodness-of-fit diagnostics.

3.4.5 Model Testing

For the model to be considered valid, all the following must hold:

i. An F test for the overall model fit must have a p-value less than 0.10 (i.e., the overall fit is statistically significant at the 10% significance level)
ii. All included variables in the model must have a p-value less than 0.2.
iii. At least one of the variables in the model must have a p-value less than 0.10
iv. The R^2 for the regression must be at least 0.5.

3.4.6 Valid Quantitative Range of Model Predictor Variables

For the model to be valid for calculating adjusted energy consumption, the average of the predictor (x) variables used to calculate the adjusted consumption from the model must fall within either:

i. The range of observed data that went into the model OR
ii. Three standard deviations from the mean of the data that went into the model.

Any outliers excluded from the model fit are also excluded in calculating the valid range.

3.4.7 Valid Quantitative Range of Other Quantifiable Conditions Not Included in the Model

i. Some factors may be tested in the regression model and found to be non-significant because they don't vary over the historic period. However, if these factors do vary in the future from the historic conditions, the historic baseline may no longer be valid. Examples include:
   - number of shifts or weekly operating hours
   - input temperature, purity, or moisture content

ii. For terms that logically would be expected to affect consumption but are not included in the model because they are found to be not statistically significant or because they don't vary over the fitting period, the valid quantitative range is defined in the same way as for variables included in the model.

3.4.8 Valid Qualitative Factors

For the model to be valid for calculating adjusted energy consumption, qualitative factors must also be similar between the model fitting period and the period the fitted model is applied to. Required conditions for qualitative factors are:

i. No major changes to facility product types
ii. Measurement points used in establishing the baseline model are still functioning

3.4.9 Modeling Different Operating Modes

If a facility has two or more different modes of operation either seasonally or at irregular intervals, such that a different model or set of coefficients would apply to each mode, separate models may be estimated for each mode. Typically, this approach will mean that fewer observations are available to fit the model in each mode.

In some cases a better overall fit might be obtained by using an additional variable that accounts for the different consumption patterns in different modes. For example, rather than fitting a different model for 1-shift and 2-shift operations, it may be possible to include a variable corresponding to daily operating hours of key lines, and fit a single model for both sets of conditions. Similarly, separate models may be fit for summer and winter conditions, but a combined model might also be valid, incorporating heating and cooling degree-days as well as product or input characteristics.

If a multi-mode model is used, the adjusted consumption must be calculated using the mode corresponding to the conditions at which the adjusted consumption is being calculated. If the conditions for calculating adjusted consumption vary over the year, the model corresponding to the mode for each part of the year must be used to calculate adjusted consumption for that part of the year.

3.4.10 Additional Requirements for Complex Models

As described in Section 3.1.3, there are two types of complex regression models:

1. Polynomial models.
2. General nonlinear regression models.

As noted in Section 3.2.2, a polynomial regression model is a linear regression model with the higher power terms such as x_1x_2 or x^2 treated as separate variables in the linear model. When applying the validity requirements above for such models, each higher power term must satisfy all the requirements described for individual variables in the model.

For either kind of complex model, one or more of the following rationales for the particular complex model specification used must be provided.

1. The model specification corresponds to a known underlying physical/engineering relationship, or a simplification of a known underlying physical/engineering relationship.
2. The model specification is a polynomial approximation (such as a quadratic fit) to a more complicated theoretical form.
3. The model specification empirically has been tested and found to meet the validity criteria of Section 3.4.5 not only for the particular data series of the baseline or reporting period, but also over other time periods or data sets.
4. Other rationale may be approved by the SEP Administrator.

3.4.11 Allowance for Models Not Satisfying All the Explicit Model Validity Requirements

Under some circumstances, a model may be approved as valid by the SEP Administrator even though it does not satisfy all the explicit requirements of 3.4.1 through 3.4.10. In such cases, the model and justification for its validity must be submitted with the application.

3.4.12 Use of the Forecast, Backcast, or Standard Conditions Adjustment Model Application Methods

The Forecast adjustment model application method can be used if the reporting-period conditions fall in the range of validity of the baseline model. The Backcast adjustment model application method can be used if the baseline conditions fall within the range of validity of a reporting-period model.

The Backcast method may be useful in particular if a facility has energy consumption data from the baseline period, but has detailed production data adequate to fit an adjustment model only for the reporting period. For example, the Backcast method can be applied if there is monthly or finer production data corresponding to the consumption data for the reporting period, but only annual total energy and production data for the baseline year.

The Standard Conditions adjustment model application method is most useful for continuous tracking and updating. This method allows tracking of an SEnPI on a continuous basis, rather than in reference to a baseline established 3 years earlier. For this method, it is necessary to establish standard model input conditions reflecting typical historical and likely future conditions. Conditions to consider include the following:

- Weather—use Typical Meteorological Year (TMY)
- Production levels
- Input levels, or ratio of inputs to product

The standard conditions model input conditions could be based on the average over past 3 years, the average over a longer period of time, or the average over a subset of the past 3 years. The latter choice may be used if the future is expected to be more like the subset than the overall history.

For example, suppose that production levels range from 100 to 750 tons per day over the past 10 years, and are projected to average around 450 tons per day over the next several years. Each month a model could be re-estimated using the most recent 12 months of production and weather data. Each month's model would be applied at 450 tons per day of production, and the same TMY weather. This would provide a basis for tracking annual consumption at a standard production level and weather conditions.

If a facility has a large weather-dependent energy consumption component, the Forecast or Backcast adjustment model application methods will adjust the energy savings to the baseline or reporting period weather conditions, respectively. The resulting SEnPI will be affected by whether the weather conditions used for normalization are mild, extreme, or typical. This weather dependency of the SEnPI can be avoided by using the standard conditions method, and normalizing to a typical weather year. However, the standard conditions method requires that a model can be fit for both the baseline and reporting-period years.

3.5 Time Periods Required for Baseline and Reporting Period

3.5.1 Typical Time Periods

Ordinarily, the baseline and reporting-period (adjusted) consumption will each be based on 12 consecutive months of data. The full year of data is required to ensure that seasonal variation is reflected in the comparisons. The requirement to use a full year of data applies whether the data used to calculate the SEnPI are bi-monthly, monthly, or at a finer interval. SEP Administrator approval is needed if the data used are finer than weekly, such as daily or hourly.

To demonstrate change over a 3-year period, a total of 48 months of data is required, from the first month of the baseline period to the last month of the reporting period. That is, the baseline period is the first 12 months of data and the reporting period is the most recent 12 months of data, ending 3 years later than the baseline period.

3.5.2 Reduced Timeframe Justification

To qualify for the Energy Performance pathway, the energy performance improvement may be demonstrated over a period of 1 or 2 years rather than 3 years if one or more of the following reduced timeframe justifications is true:

1. Changes have occurred in operations and product such that a meaningful baseline cannot be constructed from the earlier year(s) requiring a shorter period of analysis.
2. Data are not available from earlier years to allow construction of normalized consumption.
3. The facility began its Energy Management System (EnMS) program less than 3 years ago, and wishes to use the year immediately prior to its EnMS start as the baseline.

Similarly, to demonstrate change over a 10-year period a total of 132 months of data are required, from the first month of the baseline period to the last month of the reporting period. That is, the baseline period is the first 12 months of data and the reporting period is the most recent 12 months of data, ending 10 years later than the baseline period.

To qualify for the Mature Energy pathway, the energy performance improvement may be demonstrated over a period of 5 to 9 years rather than 10 years if one or more of the following is true:

1. Changes have occurred in operations and product such that a meaningful baseline cannot be constructed from the earlier year(s) requiring a shorter period of analysis.
2. Data are not available from earlier years to allow construction of normalized consumption.
3. The facility began its EnMS less than 10 years ago, and wishes to use the year immediately prior to its EnMS start as the baseline.

The table below indicates the total months of data required and the months included in the baseline and reporting periods for different lengths of the achievement period.

Table 3-4. Months of Data Used for SEnPI Calculations

Pathway	Achievement Period (years)*	Consecutive Months of Energy Data required	Baseline Period		Reporting Period	
			Begin Month	End Month	Begin Month	End Month
Energy Performance	3	48	1	12	37	48
Energy Performance	2	36	1	12	25	36
Energy Performance	1	24	1	12	13	24
Mature Energy	10	132	1	12	121	132
Mature Energy	9	120	1	12	109	120
Mature Energy	8	108	1	12	97	108
Mature Energy	7	96	1	12	85	96
Mature Energy	6	84	1	12	73	84
Mature Energy	5	72	1	12	61	72

*Highlighted rows indicate the required period unless a reduced timeframe justification applies.

3.6 Using Adjustment Model Application Methods to Determine Energy Performance Improvement Relative to Baseline

3.6.1 Confirm Model Validity

To apply adjustment models to calculate the SEnPI by any of the adjustment model application methods, it is first necessary to determine if the facility-wide baseline model is still valid for reporting-period conditions, based on the validity requirements of section 3.4. This determination includes the following steps:

a) Review the baseline conditions, measurement points and algorithm(s).
b) Establish reporting-period conditions.
c) Compare the baseline range of validity to reporting-period conditions.
d) Identify any major changes in other factors not explicitly modeled which could invalidate the baseline regression model. Examples:
   i. Major production processes added and/or deleted within the facility
   ii. Major change in inputs to final product (e.g., using partially refined product rather than raw input)
   iii. Change in number of shifts operated

3.6.2 Using the Forecast Adjustment Model Application Method

The Forecast method can be used if reporting-period conditions are within the valid range for the baseline conditions. In this case, apply the baseline model using actual reporting-period conditions. Assess improvement in terms of reporting-period actual consumption vs baseline modeled consumption with reporting-period conditions.

$$SEnPI = \frac{BTU_{RptPd}}{B\hat{T}U_{Base|RptPd}}$$

where the $B\hat{T}U_{Base|RptPd}$ is the baseline model applied at reporting-period conditions, and BTU_{RptPd} is actual reporting-period total BTU.

Energy Performance Improvement (%) = (1-SEnPI) x 100%

The requirement is met if energy improvement by this measure is greater than the designated percent from Table 3-1.

3.6.3 Using the Backcast Adjustment Model Application Method

If reporting-period conditions are not within the valid range of the baseline conditions, a Backcast adjustment model application method may be used, provided the conditions described at 3.6.3.1. are met.

3.6.3.1 Conditions for Using the Backcast Method

The Backcast method may be used if the baseline conditions fall within the range of validity of a reporting-period model. This method may be useful if reporting-period and recent conditions fall outside the valid range of the baseline model, but include that range. That is, a new model can be fit using recent history, and the baseline conditions would fall within the valid range of the new model, using the range validity definition of 3.4.6. Examples would be that the production levels or input levels fell within a relatively narrow range during the baseline historical period, but spanned a broader range in the more recent period.

3.6.3.2 Steps for Using the Backcast Method

i. Fit a model using the reporting-period data.
ii. Improvement relative to the baseline is calculated as

$$\mathrm{SEnPI} = \frac{\mathrm{B\hat{T}U}_{\mathrm{RptPd|Base}}}{\mathrm{BTU}_{\mathrm{Base}}}$$

where $\mathrm{B\hat{T}U}_{\mathrm{RptPd|Base}}$ indicates the reporting-period models applied at the baseline conditions, and $\mathrm{BTU}_{\mathrm{Base}}$ indicates actual baseline period consumption.

Energy Performance Improvement (%) = (1-SEnPI) x 100%

The requirement is met if energy improvement by this measure is greater than the threshold percent from Table 3-1.

3.6.4 Using the Standard Condition Adjustment Model Application Method

This method may be used for continuous tracking and updating using standard conditions, as described in section 3.4.10. Steps are as follows:

a) Fit models of the same specification to data from the baseline period and separately to data for the reporting period.
b) Apply each model using the standard conditions established for each predictor variable, for each energy source. This step can be performed on a monthly or more frequent basis. The modeled energy consumption, fit with data from the most recent 12 months and applied at the standard conditions, can serve as an SEnPI tracked continuously, without reference to a particular baseline point.
c) Sum the standard condition energy sources to total BTUs.

d) Improvement relative to the baseline is calculated as

$$\text{SEnPI} = \frac{\hat{\text{BTU}}_{\text{RptPd|Std}}}{\hat{\text{BTU}}_{\text{Base|Std}}}$$

where $\hat{\text{BTU}}_{\text{Base|Std}}$ and $\hat{\text{BTU}}_{\text{RptPd|Std}}$, respectively, indicate the baseline and reporting-period models, both applied at the standard conditions.

Energy Performance Improvement (%) = (1-SEnPI) x 100

The requirement is met if energy improvement by this measure is greater than the threshold percent from Table 3-1.

3.6.5 Using SEnPI Chaining Adjustment Model Application Method

This method may be useful if the reporting-period conditions are outside the range of conditions of the baseline model, and the baseline conditions are outside the range of conditions of the reporting-period model, and there is no standard condition in the range of both a baseline and reporting-period model. The chaining method may be used if there is a period between the baseline and the reporting-period year for which a model can be fit whose range of validity includes both the baseline and reporting-period years. In this case the mid-period model is used to backcast to the baseline year and forecast to the reporting-period year. The SEnPI for the period from base to reporting-period year is calculated as the product of

1) an EnPI from base to midperiod, using the backcast from the midperiod model, and

2) an EnPI from midyear to reporting-period, using the forecast from the midperiod model.

Specifically:

The backcast EnPI from base to midperiod is

$$\text{EnPI}_{\text{Mid:Base}} = \frac{\hat{\text{BTU}}_{\text{Mid|Base}}}{\text{BTU}_{\text{Base}}}$$

The forecast EnPI from midperiod to reporting-period is

$$\text{EnPI}_{\text{RptPd:Mid}} = \frac{\text{BTU}_{\text{RptPd}}}{\hat{\text{BTU}}_{\text{Mid|RptPd}}}$$

The chained SEnPI from baseline to reporting-period period is the product of these two.

$$
\begin{aligned}
SEnPI_{RptPd:Base} &= EnPI_{Mid:Base} \times EnPI_{RptPd:Mid} \\
&= \frac{B\hat{T}U_{Mid|Base}}{BTU_{Base}} \frac{BTU_{RptPd}}{B\hat{T}U_{Mid|RptPd}} \\
&= \frac{BTU_{RptPd}}{BTU_{Base} \dfrac{B\hat{T}U_{Mid|RptPd}}{B\hat{T}U_{Mid|Base}}}
\end{aligned}
$$

Energy Performance Improvement (%) = (1-$SEnPI_{RptPd:Base}$) x 100

The requirement is met if energy improvement by this measure is greater than the threshold percent from Table 3-1.

3.6.6 Alternative Adjustment Model Application Methods

In cases where none of the methods described in section 3.6.2 through 3.6.5 can be used to model a facility's energy performance effectively, the facility may apply to the SEP Administrator for approval to use an alternative modeling application method. The alternative modeling application method must use observed consumption data from the baseline or reporting period, and must explicitly or implicitly provide a comparison between the baseline and reporting period consumption under consistent conditions as described under Section 3.4.1.The alternative methodology and calculations must be approved by the SEP Administrator.

3.6.7 Non-routine Adjustments

Adjustment models as described in Section 3.2 and applied as described in Sections 3.6.2 through 3.6.6 are intended to describe the relationship between consumption and production or other factors based on analysis of observed consumption data at varying levels of those factors. Non-routine adjustments are adjustments for one-time changes between the baseline and reporting period to otherwise constant conditions or static factors within a defined boundary. Because these changes are constant at one level or condition during the baseline period, and constant at a different level or condition during the reporting period, it is not possible to determine and adjust for the effect of these factors based on analysis of observed consumption in each period. Thus, an adjustment model based on that type of analysis as described above cannot be used to adjust for these one-time changes.

Examples of one-time changes that might require a non-routine adjustment include:

- A new ventilation system is added to comply with a new regulatory requirement. The appropriate baseline condition is therefore one that includes the new ventilation system, but no data exist from operations under the other baseline operating conditions together with the new ventilation system.

- A supplier goes out of business, and an equivalent input is not available. A process modification is needed to use a different type of input. No data exist for baseline operating conditions with the new type of input.

In such cases, it is necessary to develop reasonable baseline and reporting-period BTU estimates for consistent production levels, input type, and external conditions and requirements. These estimates will typically be based on a modeled relationship as described above, with an additional adjustment for one-time effects. Any numeric inputs to this non-routine adjustment calculation must be based on observed, measured, or metered data, as appropriate for the type of input.

The non-routine adjustments are typically based on an engineering analysis to calculate consumption in the baseline and reporting periods as if the static factors were at the same condition in both. Typically the adjustment will be to calculate baseline consumption as if the reporting-period condition of the static factors had been true in the baseline period.

The method for making the non-routine adjustment and the rationale for that method must be documented. Non-routine adjustments must be identified in the application to the SEP Administrator. The Performance Verifier will verify the general reasonableness of the methodology and calculations, the adequacy of the metering and monitoring methodologies, and conformance of the calculations applied with the documented methods.

3.6.8 Bottom-Up Sanity Check

This check is performed on the energy performance reported as the result of top-down analysis. The sanity check confirms that the calculated energy performance improvement could reasonably have resulted from the known steps that were taken to improve the energy performance. Steps taken to improve performance include changes in procedures, behavior, operations, equipment, and processes. The bottom-up sanity check consists of the following.

1. The facility must provide a list of projects or actions that have been taken during the achievement period, together with approximate savings estimates, summing up to at least the threshold savings. The list may be a subset rather than a comprehensive list of all significant actions taken. The savings estimates may be rough. For the list provided a SEP Performance Verifier will

    i. Confirm the sum of these savings estimates exceeds the savings threshold.
    ii. Spot check individual project calculations

2. The SEP Performance Verifier will confirm that any other changes or interactions that might reduce the total facility-level savings either
    i. Have been accounted for in the savings estimates adequately OR
    ii. Are not large enough collectively to bring the total savings below the threshold

In cases where records of specific actions taken in the early part of the achievement period are not available, the list of actions in part 1 and the review of changes at part 2 may span a shorter period of time. The shorter period of time must be continuous and end at the end of the achievement period. The sanity check will review the list of projects that fell within this shorter period, if such a list is provided, and will review other changes or interactions that need to be considered, if any. If a list of projects is provided per item 1, the sum of the savings from these actions must exceed the savings threshold pro-rated by the length of the shorter period reviewed. For example, if records on specific projects are available only for the past 2 years of a 3-year achievement period, the sum of the savings from the listed projects must exceed 2/3 of the savings threshold.

3.7 Converting Delivered Energy Sources to Primary Energy

All energy sources entering a facility must be accounted for regardless of their form. Imported electricity, hot water, steam, and chilled water all provide energy services and are considered energy sources. The amounts of these energy sources consumed at the site must be converted to the primary energy, the amount of energy consumed in their production.

3.7.1 Conversion of Electricity to Primary Energy

The electric energy delivered is expressed in BTU delivered by multiplying the kWh delivered by the units conversion factor of 3412 BTU/kWh. Primary BTU are calculated by multiplying the delivered BTU by a source conversion factor (i.e. a multiplier) of 3 for electric energy delivered from the grid and of 1.0 for onsite generation from non-fuel, geophysical processes (e.g. solar and wind generation).

3.7.2 Conversion of Other (Non-Electric) Derived Energy Sources to Primary Energy

Conversion of other derived energy sources from delivered energy quantities to primary energy quantities follows the same method as for electricity. First, the delivered energy quantity is expressed in BTU, by applying a unit conversion factor. Second, a production energy source conversion multiplier is applied. This multiplier is the input BTUs required at the derived energy source production site to produce each BTU delivered to the participating facility. When the derived energy source is produced by electricity, an additional multiplier of 3.0 is applied to translate the production energy source back to the primary energy for the electricity.

For each of the derived energy sources listed in Table 3-5, SEP allows for two options for the conversion factors: a set of default factors based on an approximate national average or typical conversion factors, and a site-specific overall factor. The table gives the default factors for each source.

- **Default Method** – The delivered energy is expressed in BTU by multiplying by the default unit conversion factor. Primary BTU are calculated by multiplying the delivered BTU by a default source conversion factor (i.e. a multiplier). If the production energy source for the derived energy source is electricity, an additional electric energy source conversion multiplier of 3.0 is applied. If the production energy source is not electricity or another derived energy source, this multiplier is 1.0.

- **Site-Specific Method** – If the facility has an existing energy accounting system used regularly for purposes other than SEP compliance or a methodology using generally accepted engineering practices that applies a different set of multipliers to convert the delivered energy to primary energy, that existing system or methodology may be used, provided:
  1. the system's explicit or implicit electric energy source conversion multipliers for any renewable energy source are at least 1.0, and
  2. the system's multipliers for generation of the derived energy sources from fossil fuels account for generation efficiency.
  3. If the derived energy source is generated by electricity, the system explicitly or implicitly includes a 3.0 multiplier as well as a production multiplier.
  4. If the derived energy source is generated by a non-electric derived energy source, the system explicitly or implicitly includes an appropriate derived energy source multiplier as well as a production multiplier.

Table 3-5. Unit Conversion Factors and Primary Energy Multipliers

Energy Source	Delivery Measurement Units	Unit Conversion Factor		Production energy conversion multiplier formula	Production energy conversion default factor	Electric Energy Source Conversion Multiplier
Steam	Pounds	Per steam tables[2] (temperature and pressure must be known)	BTU/lb	1/Combustion system efficiency (applicable for non-electric boilers)	1.33 (applicable for non-electric boilers)	1.0 for fired boilers 3.0 for electric boilers
Hot water	Hot water volume (gallons/yr) multiplied by temperature difference between pre-heated and delivered hot water	8.34	BTU/gal°F	1/combustion system efficiency (applicable for non-electric boilers)	1.33 (applicable for non-electric boilers)	1.0 for fired boilers 3.0 for electric boilers
Chilled Water	Cooling demand in ton-hours/yr	12,000	BTU/ton-hour	1/COP	1.25 Absorption chiller default 0.83 Engine-driven compressor default	1.0 1.0

[2] Values taken from steam tables should subtract out the enthalpy (Btu/lb) of water at inlet conditions.

Energy Source	Delivery Measurement Units	Unit Conversion Factor		Production energy conversion multiplier formula	Production energy conversion default factor	Electric Energy Source Conversion Multiplier
Chilled Water	Chilled water volume (gallons/yr) Multiplied by temperature difference between the pre-chilled and chilled water	8.34	BTU/(gal ^{o}F)		.24 Electric-driven compressor	3.0
Compressed Air[3]	Volume (ft^3) at 100 psi, for motor driven compressors	10.93	Btu/ft^3	1	1	3
Solar	kWh	3412	Btu/kWh	1	1	1
Wind	kWh	3412	Btu/kWh	1	1	1

For derived energy sources not listed in this table, the primary energy must be quantified using metered data for the derived energy input plus standard and recognized engineering methods, and data from credible sources, taking into account relevant factors that fully define the condition of the derived energy source. Compressed gases consumed as a derived energy source, for example, will be defined by pressure, temperature, flow rate, and enthalpy. Changes in these parameters can be measured to calculate the energy consumed. The energy to produce that state and quantity of the gas at the fence line must be estimated to achieve the primary energy. If electric energy from the grid is consumed to produce the compressed gas, the source factor of 3 must also be included in the calculation. The methodology and calculations must be approved by the SEP Administrator.

3.7.3 Non-Derived Energy Sources

For energy sources that are not derived from other energy sources and are not feedstocks, such as natural gas combusted on-site for process heat, consumption is accounted for as the amount of energy delivered and consumed in Btu. If the delivered energy is reported by the supplier by volume, the energy consumed is calculated by multiplying the energy content per unit volume by the volume consumed. Energy content per unit volume should typically be available from the fuel supplier. If the energy delivered is reported by the supplier in physical energy units other than Btu, the delivered amount is converted to Btu using the physical unit conversion factors, such as therms per Btu. The higher heating value (HHV)

[3] Compressed air default value assumes a motor driven compressor at 100 psi only. The value of compressed air as an energy source under other conditions can be calculated using site-specific conditions of delivered pressure, the efficiency of the compression equipment for the compression ratio needed at the delivered pressure, the altitude, the efficiency of the part load control mechanisms and controls, and the efficiency of the motor(s), engines or turbines driving the compression equipment.

of energy sources must be used in calculating input Btu. Consumption accounting details are provided in Section 3.8.

The energy associated with transporting non-derived energy sources to the facility fence line is not included. For example, natural gas transmission or transportation losses prior to entering the facility do not need to be accounted for in the energy performance calculations.

3.8 Calculating Consumption

This section addresses how consumption must be calculated, accounting for pass-through energy sources and feedstocks, and on-site energy generation.

3.8.1 Accounting for Pass-through Sources, Feedstocks and Inventory

Some inputs may be used by a facility as a feedstock or as an energy source, or as both. This situation is particularly common in petroleum and chemical facilities. Some energy sources are delivered in bulk and stored, or produced as waste streams and stored on site.

The energy consumed of a particular energy source is defined as the net energy content of that source. The basic calculation of consumed energy accounting for feedstocks and stored fuel consumption is as follows:

Energy consumed of energy source A

= (Energy content of energy source A input to the participating facility from outside)

- (Energy content of the amount of energy source A used as feedstock)

- (Energy content of energy source A sold or transferred to outside the facility)

+ (Energy content of energy source A stored on site at the start of the period)

- (Energy content of energy source A stored on site at the end of the period).

This calculation of energy consumption net of transfers, feedstock use, and changes to inventory is done separately for each input energy source. For example, suppose that a facility has a particular petroleum distillate as an input from outside, and the facility uses the distillate to produce gasoline for sale, also uses distillate as a fuel, and sells excess distillate to another facility. The amount of distillate consumed as energy would be only the portion consumed as a fuel. Neither the feedstock use nor the sales to outside would be counted as energy consumption.

Moreover, the gasoline sold outside would not be counted as a fuel (with negative consumption) but as a (generation) product. Accounting for the net consumption of each input energy source separately helps avoid incorporating large volumes of product fuels into the energy accounting.

Similarly, any energy source that is “passed-through” a facility, where it is purchased for use in one form and exported in the same form, is netted out in the energy calculation indicated above. For example, if a facility purchases 100 barrels of oil and re-sells 50 barrels to an outside entity, the energy consumption would be 50 barrels. Exported energy sources do not negate consumption of a different energy source.

Converted or derived energy (e.g. steam or electricity produced from a Combined Heat and Power (CHP) system) is considered a generation product as described above, whereas pass-through energy is simply unused input energy.

Changes to inventory must be accounted for by measured data, according to the data quality provisions of section 3.9.

3.8.2 On-site Production of Electricity or Other Derived Energy Sources

Some facilities have onsite generation for one or more derived energy sources, such as electricity or steam. The amount of onsite generated energy sources is not counted explicitly in the energy consumption calculation for purposes of the SEnPI. Only consumption of sources entering the facility from outside are counted. Energy sources that originate from non-fuel geophysical processes, such as solar, wind, or geothermal energy are considered to have entered the facility from outside. The “credit” for reduced consumption of an external energy source due to onsite generation or consumption of byproducts as a fuel shows up as reduced consumption of the outside source. For example, if a facility moves from purchasing all its electricity to generating some or all its electricity needs on site through CHP, consumption of electricity (from outside) will be reduced, even if consumption within the facility

(including onsite generation) is unchanged. However, if the facility uses solar photovoltaic cells to generate electricity onsite, the electricity source comes from outside (the sun), and the energy consumption must be included in the accounting.

Some facilities with onsite generation of electricity sell excess power at times, and purchase electricity at other times. When calculating electricity consumption, electricity sold to outside parties within a given period (reporting period or baseline) may be subtracted from the electricity delivered from outside, as long as the difference (net electricity consumption) is not negative. The net electricity calculation is done in units of kWh delivered to the facility and kWh exported from the facility. The multiplier to convert electricity to primary energy is applied to the net electricity consumption. Thus, implicitly, delivered electricity and exported electricity are both converted to primary energy sources using the same multiplier, regardless of the type of onsite generation.

If electricity exports are greater than electricity consumption, the exported electricity (or the exported amount in excess of electric consumption) is considered to be a (generation) product, not a subtraction from consumption. If the amount of an energy source consumed depends on the amount of electricity exported, this relationship should be included in the model for that energy source for purposes of calculating the SEnPI. That is, the SEnPI should be calculated for consistent levels of production of both manufacturing and generation products. If the energy source consumption is driven by other factors and is not affected by the amount of exported electricity, the exported amount will not affect the SEnPI. A similar principle applies for other onsite generated energy sources.

For example, a facility may operate a gas-fired CHP unit solely to support on-site needs, but may generate residual steam or electricity which is sold. In this case, the natural gas required for the facility’s needs is independent of the exported energy quantity. The export of steam or electricity is a by-product that does not materially drive natural gas consumption and therefore would not be included in the model used to calculate adjusted consumption. On the other hand, if the facility operates the CHP unit specifically to sell steam or electricity rather than for on-site needs, the energy sold is a generation product that drives gas consumption. In this case, the energy sold would be a generation product tested for inclusion in the adjustment model.

3.8.3 Other Situations for Adjustment

There are other situations that are not addressed explicitly in the protocol that may require adjustments. Some examples are:

a. Onsite electricity generation from solar or wind may vary from year to year due to factors outside the facility control. An adjustment may be needed to compare reporting period to baseline consumption under consistent conditions for these outside factors.

b. Use of increasing amounts of biomass as energy. Use of biomass is encouraged by the Superior Energy Performance Program. However, the combustion efficiency of biomass is typically less than that of conventional energy sources such as fossil fuels. If a participating facility shifts to using biomass to a greater extent, a voluntary adjustment may be used to compare reporting period to baseline consumption as if the extent of biomass consumption were the same in both periods.

c. Heat recovery or electricity generation from exothermic reactions. Similarly to the situation for onsite solar or wind electricity generation, the amount of energy generated from exothermic reactions may vary from year to year due to factors outside the facility control. An adjustment may be needed to compare reporting period to baseline consumption under consistent conditions for these outside factors.

Use of adjustment methods such as a, b, c above or others not explicitly listed in this protocol requires the approval of the SEP Administrator.

3.9 Data Quality

3.9.1 Verifiable Data

ISO 50001 requires an energy management plan to ensure that the key characteristics of the facility's operations that determine energy performance are monitored, measured, and analyzed at planned intervals. All data sources for SEnPI calculations must be of sufficient quality to be verifiable by the SEP Performance Verifier. Only data taken from highly accurate control systems, such as revenue utility meters, and regularly calibrated sub-meters are considered verifiable with the exceptions noted below for small fractions of the facility's total primary energy consumption. A subtraction method for a calibrated meter minus the sum of calibrated meters is also acceptable. Calibration records and records of repairs to calibrated meters used for the SEnPI calculations must be documented. Solid fuel measurements from scales are acceptable provided that the scale is regularly calibrated by a qualified vendor. Reports previously submitted to State or Federal government agencies (such as EIA) are also of sufficient quality for energy calculations. Weather data must be actual weather data from the baseline and performance years, from calibrated sources, such as primary NOAA weather stations.

3.9.2 Temporary Exceptions for Onsite Non-Fuel, Geophysical Generation

For onsite generation of electricity from non-fuel, geophysical processes (e.g. solar and wind generation), requirements for highly accurate control system data under Section 3.9.1 do not apply to measurements taken prior to January 2015.

3.9.3 Exceptions for Small Fractions of Total Facility Primary Energy Consumption

In the case where more than 5 percent of a facility's total primary energy consumption is not measured, a facility may meet SEP requirements provided the following are satisfied:

1. At least 75% of the primary energy consumption must be metered, with equipment satisfying the requirements of Section 3.9.1.

2. Unmetered primary energy performance must be estimated in a reasonable worst case scenario. Specifically,

    a. The consumption of the unmetered source must be assumed to be at least as great in the reporting period as in the baseline period.

    b. If the unmetered source could reasonably have increased from the baseline period to the reporting period, the largest reasonable increase must be assumed.

    c. The largest possible magnitude of the unmetered source must be assumed, given the equipment specifications and operation.

3. A calculation for deriving the unmetered energy consumption must be documented. Documentation must include supporting site-specific engineering data, such as an equipment list with specifications and operational characteristics sufficient to determine capacity, load, efficiency, and energy consumption.