ENERGY STAR® Portfolio Manager®

Technical Reference

# ENERGY STAR Score for Offices in the United States

## OVERVIEW

The ENERGY STAR Score for Offices applies to office, bank branch, financial office, and courthouse property types. The objective of the ENERGY STAR score is to provide a fair assessment of the energy performance of a property relative to its peers, taking into account the climate, weather, and business activities at the property. To identify the aspects of building activity that are significant drivers of energy use and then normalize for those factors, a statistical analysis of the peer building population is performed. The result of this analysis is an equation that will predict the energy use of a property, based on its experienced business activities. The energy use prediction for a building is compared to its actual energy use to yield a 1 to 100 percentile ranking of performance, relative to the national population.

- Property Types. The ENERGY STAR score for offices applies to four property types: office, financial office, bank branch, and courthouse. The score applies to individual buildings only and is not available for campuses.
- Reference Data. The analysis for offices is based on data from the Department of Energy, Energy Information Administration's 2003 Commercial Building Energy Consumption Survey (CBECS).
- Adjustments for Weather and Business Activity. The analysis includes adjustments for:
    - Building Size
    - Number of Personal Computers
    - Number of Workers
    - Hours of Operation per Week
    - Weather and Climate (using Heating and Cooling Degree Days, retrieved based on Zip code)
    - Percent of the Building that is Heated and Cooled
    - Whether or not the building is a Bank Branch (Smaller banks show different performance)
- Release Date. The ENERGY STAR score for offices is updated periodically as more recent data becomes available:
    - Most Recent Update: October 2007
    - Previous Update: January 2004
    - Original Release: January 1999

This document presents details on the development of the 1 - 100 ENERGY STAR score for office properties. More information on the overall approach to develop ENERGY STAR scores is covered in our Technical Reference for the ENERGY STAR Score, available at www.energystar.gov/ENERGYSTARScore. The subsequent sections of this document offer specific details on the development of the ENERGY STAR score for offices:


OVERVIEW ..... 1
REFERENCE DATA & FILTERS ..... 2
VARIABLES ANALYZED ..... 4
REGRESSION EQUATION RESULTS ..... 7
SCORE LOOKUP TABLE ..... 9
EXAMPLE CALCULATION ..... 11

## REFERENCE DATA & FILTERS

For the ENERGY STAR score for office properties, the reference data used to establish the peer building population in the United States is based on data from the Department of Energy, Energy Information Administration's (EIA) 2003 Commercial Building Energy Consumption Survey (CBECS). Detailed information on this survey, including complete data files, is available at: http://www.eia.doe.gov/emeu/cbecs/contents.html.

To analyze the building energy and operating characteristics in this survey data, four types of filters are applied to define the peer group for comparison and to overcome any technical limitations in the data: Building Type Filters, Program Filters, Data Limitation Filters, and Analytical Filters. A complete description of each of these categories is provided in our Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARScore. *Figure 1* presents a summary of each filter applied in the development of the ENERGY STAR score for offices, the rationale behind the filter, and the resulting number of properties in the data set after the filter is applied. After all filters are applied, the remaining data set has 498 properties.

*Figure 1 – Summary of Filters for the ENERGY STAR Score for Offices*

| Condition for Including an Observation in the Analysis | Rationale | Number Remaining |
|---|---|---|
| PBAPLUS8=2, 3, or 4 or Court8=1 | Building Type Filter – CBECS defines building types according to the variable "PBAPLUS8." Offices are coded as PBAPLUS8=2 and 4; Bank/Financial Institutions are coded with PBAPLUS8=3; Courthouses are designated by a 1 value in a separate variable, COURT8.[1] | 755 |
| Must have at least 1 personal computer (PC) | Program Filter – Baseline condition for being a functioning office building, there must be PCs. | 750 |
| Must operate for at least 30 hours per week | Program Filter – Baseline condition for being a full time office. | 746 |
| Must operate for at least 10 months per year | Program Filter – Baseline condition for being a full time office. | 727 |
| Office activity must characterize more than 50% of the floor space[2] | Program Filter – In order to be considered part of the office peer group, more than 50% of the building must be used as one of those activities. | 698 |
| Must have square foot <=1,000,000 | Data Limitation Filter – CBECS masks surveyed properties above 1,000,000 square feet by applying regional averages. | 672 |
| If propane is used, the amount category (PRAMTC8) must equal 1, 2, or 3 | Data Limitation Filter – Cannot estimate propane use if the quantity is "greater than 1000" or unknown. | 662 |

[1] The variable COURT8 is not presented in the public 2003 CBECS data set. Because courthouses were identified and incorporated in the previous ENERGY STAR score for offices, EPA requested and received this information from EIA.
[2] If the variable ONEACT8=1, this indicates that one activity occupies 75% or more of the building. If the variable ONEACT8=2, then the building can specify up to 3 activities (ACT18, ACT28, ACT38). One of these activities must Office (PBAX=11) or Public Order and Safety (PBAX=22), and must account for more than 50% of the floor area.

| Condition for Including an Observation in the Analysis | Rationale | Number Remaining |
|---|---|---|
| If propane is used, the maximum estimated propane amount must be 10% or less of the total source energy | Data Limitation Filter – Because propane values are estimated from a range, propane is restricted to 10% of the total source energy. | 660 |
| Must not use chilled water | Data Limitation Filter – CBECS does not collect quantities of chilled water. | 625 |
| Must have square foot >= 5,000 | Analytical Filter – Analysis could not model behavior for buildings smaller than 5,000 $ft^2$. | 498 |

The reasons for applying filters on the use and quantity of propane are worthy of additional discussion. In CBECS, major fuel use is reported in exact quantities. However, if a building uses propane, the amount of propane is reported according to the variable PRAMT8, which uses ranges rather than exact quantities (e.g., less than 100 gallons, 100 to 500 gallons, etc). Therefore, the quantity must be estimated within the range. To limit error associated with this estimation, EPA applies two filters related to propane.

1. The quantity of propane expressed by PRAMT8 must be 1000 gallons or smaller.
2. The value of propane cannot account for more than 10% of the total source energy use. Because the exact quantity of propane is not reported, this cap ensures that the quantity of propane entered will not introduce undue error into the calculation of total energy consumption. In order to determine if the 10% cap is exceeded, the value at the high end of the propane category is employed (e.g., for the category of less than 100, a value of 99 is used). If the 10% cap is not exceeded, then EPA will use the value at the middle of the range to calculate total energy use for the regression analysis (e.g., for the category of less than 100, a value of 50 is used).

Of the filters applied to the reference data, some result in constraints on calculating a score in Portfolio Manager and others do not. Building Type and Program Filters are used to limit the reference data to include only properties that are eligible to receive a score in Portfolio Manager, and are therefore related to eligibility requirements. In contrast, Data Limitation Filters account for limitations in the data availability, but do not apply in Portfolio Manager. Analytical Filters are used to eliminate outlier data points or different subsets of data, and may or may not affect eligibility. In some cases, a subset of the data will have different behavior from the rest of the properties (e.g., office buildings smaller than 5,000 $ft^2$ do not behave the same way as larger buildings), in which case an Analytical Filter will be used to determine eligibility in Portfolio Manager. In other cases, Analytical Filters exclude a small number of outliers with extreme values that skew the analysis, but do not affect eligibility requirements. A full description of the criteria you must meet to get a score in Portfolio Manager is available at www.energystar.gov/EligibilityCriteria.

Related to the filters and eligibility criteria described above, another consideration is how Portfolio Manager treats properties that are situated on a campus. The main unit for benchmarking in Portfolio Manager is the property, which may be used to describe either a single building or a campus of buildings. The applicability of the ENERGY STAR score depends on the type of property. For office properties, the score is based on individual buildings, because the primary function of the office is contained within a single building and because the properties included in the reference data are single buildings. In cases where multiple offices are situated together (e.g., an office park), each individual building can receive its own ENERGY STAR score, but the campus cannot earn a score.

# VARIABLES ANALYZED

To normalize for differences in business activity, we perform a statistical analysis to understand what aspects of building activity are significant with respect to energy use. The filtered reference data set described in the previous section is analyzed using a weighted ordinary least squares regression, which evaluates energy use relative to business activity (e.g., operating hours, number of workers, and climate). This linear regression yields an equation that is used to compute energy use (also called the dependent variable) based on a series of characteristics that describe the business activities (also called independent variables). This section details the variables used in the statistical analysis for offices.

## Dependent Variable

The dependent variable is what we try to predict with the regression equation. For the office analysis, the dependent variable is energy consumption expressed in source energy use intensity (source EUI). This is equal to the total source energy use of the property divided by the gross floor area. The regressions analyze the key drivers of source EUI – those factors that explain the variation in source energy use per square foot in offices.

## Independent Variables

The reference survey collects numerous property operating characteristics that were identified as potentially important for offices. Based on a review of the available variables in the data, in accordance with the criteria for inclusion in Portfolio Manager[3], the following variables were analyzed:[4]

- SQFT8 – Square footage
- WKHRS8 – Weekly hours of operation
- NWKER8 – Number of employees during the main shift
- PCNUM8 – Number of personal computers
- SRVNUM8 – Number of servers
- PRNTRN8 – Number of printers
- MNFRM8 – Mainframe computer room (yes/no)
- SRVFRM8 – Server farm (yes/no)
- TRNGRM8 – Computer-based training room (yes/no)
- COPRN8 – Number of photocopiers
- RFGWIN8 – Number of walk-in refrigeration units
- RFGOPN8 – Number of open refrigerated cases
- RFGRSN8 – Number of residential refrigerators
- RFGCLN8 – Number of closed refrigerated cases
- RFGVNN8 – Number of refrigerated vending machines
- COOK8 – Energy used for cooking (yes/no)
- FDRM8 – Commercial food preparation area (yes/no)
- SNACK8 – Snack bar (yes/no)
- FASTFD8 – Fast food or small restaurant (yes/no)
- CAF8 – Cafeteria or large restaurant (yes/no)

[3] For a complete explanation of these criteria, refer to our Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARScore.

[4] Note that the number 8 at the end of all variables indicates that the 2003 CBECS survey is the eighth survey conducted by the Energy Information Administration.

- ELEVTR8 – Elevators (yes/no)
- LABEQP8 – Laboratory equipment used (yes/no)
- SKYLT8 – Skylights/atriums designed for lighting (yes/no)
- HEATP8 – Percent heated
- COOLP8 – Percent cooled
- HDD658 – Heating degree days
- CDD658 – Cooling degree days

We perform extensive review on all of these operational characteristics. In addition to reviewing each characteristic individually, characteristics are reviewed in combination with each other (e.g., Heating Degree Days times Percent Heated). As part of the analysis, some variables are reformatted to reflect the physical relationships of building components. For example, the number of workers on the main shift is typically evaluated in a density format. The number of workers *per square foot* (not the gross number of workers) is expected to be correlated with the energy use per square foot. In addition, based on analytical results and residual plots, variables are examined using different transformations (such as the natural logarithm, abbreviated as Ln). The analysis consists of multiple regression formulations. These analyses are structured to find the combination of statistically significant operating characteristics that explain the greatest amount of variance in the dependent variable: source EUI.

The final regression equation includes the following variables:

- Natural log of gross square foot
- Number of personal computers (PCs) per 1,000 square feet
- Natural log of weekly operating hours
- Natural log of the number of workers per 1,000 square feet
- Heating degree days times Percent of the building that is heated
- Cooling degree days times Percent of the building that is cooled

These variables are used together to compute the predicted source EUI for offices. The predicted source EUI is the mean EUI for a hypothetical population of buildings that share the same values for each of these variables. That is, the mean energy use for a building that operates just like your building.

## Bank Branch and Financial Office Analysis

Analysis reveals that bank branches and financial offices of 50,000 square feet or smaller have different average energy consumption and different responses to size and worker density. Due to this unique response, the final regression equation also includes:

- Yes/No variable indicating whether the building is a bank branch/financial office that is 50,000 square feet or smaller *(called a small bank)*
- Adjustment for natural log of gross square foot for a small bank
- Adjustment for natural log of the number of workers per 1,000 square feet for a small bank

The determination of these adjustments is based on a substantial analysis of the data and the differences among bank branches and financial offices. Working from the hypothesis that the larger and smaller bank branches and financial offices may differ in their energy consumption, we investigated a wide variety of regression formulations. These included regressions where all bank branches and financial offices were treated the same, and regressions where a size cut-off point was established at 20,000, 30,000, 50,000, and 100,000 square feet. For each division, the average energy consumption of the groups was examined, as were the regression results and the individual impacts

of each operating characteristic. Analysis indicated that bank branches and financial offices of 50,000 square foot or smaller behave differently than their larger counterparts. This deviation is seen not only in the average energy consumption, but also in the impact that size and worker density have on energy consumption. These impacts have been incorporated into the regression equation accordingly.

## Refrigeration Analysis

Another significant area of analysis during the development of the ENERGY STAR score for offices was the use of refrigeration. Unlike previous surveys, the 2003 CBECS incorporated questions about five types of refrigeration used in commercial buildings: residential-style refrigerators, refrigerated vending machines, walk-in refrigerators, open refrigeration cases, and closed refrigeration cases. These types of equipment may be present in employee break rooms, cafeteria, or small snack bars.

We analyzed the variables in a variety of formulations, including examining each variable individually as well as looking at combinations of variables. Results of the analysis indicate that refrigeration does have an impact on energy consumption. Regression analysis showed that the effects were best captured through the use of two variables: residential refrigeration density (number of residential refrigerators and refrigerated vending machines per 1,000 square feet); and commercial refrigeration density (number of walk-in, open, and closed refrigeration units per 1,000 square feet).

The refrigeration variables were analyzed in the context of the standard Portfolio Manager criteria for inclusion in regression equations.[5] There are certain aspects of refrigeration that make it acceptable for a final regression equation, but others that suggest it should be excluded to achieve the most accurate comparisons. While refrigeration describes the physical operation of the building (i.e., should be included), it also represents a technology variable that explains how a building provides its services (i.e., should be excluded). For example, an office building may offer its employees two vending machines per floor or 20 vending machines per floor. This decision does not reflect a business constraint on the building, but rather a discretionary choice about building operation. If refrigeration were included in the equation, buildings with wasteful amounts of refrigeration would effectively receive an energy allowance to account for the wasteful decision and therefore receive an artificially high score.

Due to these unique characteristics, the impacts of refrigeration are incorporated using a unique protocol. The two refrigeration variables are used in the final regression analysis, in order to provide the best estimates for all of the other coefficients in the regression equation. However, in order to compute the predicted energy use, and to develop the lookup table used to determine the 1 - 100 ENERGY STAR score, each CBECS building is assigned the average value for both refrigeration variables. Due to the variable-centering technique, this means that each building has a centered value of zero. As such, the refrigeration variables have no impact on an individual building's predicted source EUI. This approach enables us to correctly account for the relationship between refrigeration and other key drivers of energy use, without providing undue credit to buildings that have wasteful practices. To compute an ENERGY STAR score in Portfolio Manager, buildings are treated identically to the way the CBECS buildings were treated to create the lookup table, and assigned a centered value of zero for the refrigeration variables. Thus, the density of refrigeration does not impact an individual building's predicted source EUI.

## Property Size and Personal Computer Density Analysis

The regression analysis shows that facilities with higher natural log of gross square foot have higher source EUI values on average. This relationship between source EUI and natural log of gross square foot was only observed for

[5] For a complete explanation of these criteria, refer to our Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARScore.

offices below 200,000 square foot. Therefore, the adjustment of natural log of square foot within the regression equation is applied over that range, and capped at a maximum adjustment at the value of 200,000 square feet. That is, the square foot adjustment in the regression equation for a building larger than 200,000 square feet will be identical to the adjustment for a building that is 200,000 square feet.

The regression analysis shows a similar pattern of behavior for personal computer density (number of personal computers per 1,000 square feet). Facilities with higher personal computer density have higher source EUI values on average, but the relationship was only observed up to a density of 11.1 personal computers per 1,000 square feet. Therefore, the adjustment for personal computer density within the regression equation is capped at a maximum adjustment at the value of 11.1 personal computers per 1,000 square feet. Similar to the square foot cap, this means that the personal computer density adjustment for a building with more than 11.1 personal computers per 1,000 square feet will be identical to the adjustment for a building that has 11.1 computers per 1,000 square feet.

### Testing

Finally, we test the regression equation using actual office buildings that have been entered in Portfolio Manager. This provides another set of buildings to examine in addition to the CBECS data, to see the average ENERGY STAR scores and distributions, and to assess the impacts and adjustments. This analysis provides a second level of confirmation that the final regression equation produces robust results that are unbiased with respect to the key operational characteristics such as building size, computer density, worker density, operating hours, and heating and cooling degree days.

It is important to reiterate that the final regression equation is based on the nationally representative reference data, not data previously entered into Portfolio Manager.

## REGRESSION EQUATION RESULTS

The final regression is a weighted ordinary least squares regression across the filtered data set of 498 observations. The dependent variable is source EUI. Each independent variable is centered relative to the mean value, presented in *Figure 2*. The final equation is presented in *Figure 3*. All variables in the regression equation are significant at the 95% confidence level or better, as shown by the significance levels, with the exception of worker density (a p-level of less than 0.05 indicates 95% confidence). Worker density has a slightly lower level of significance (84%). However, given the physical relationship between worker density and energy consumption, this result was considered acceptable, and therefore worker density was retained in the analysis.

The regression equation has a coefficient of determination ($R^2$) value of 0.334, indicating that this equation explains 33.4% of the variance in source EUI for office buildings. Because the final equation is structured with energy per square foot as the dependent variable, the explanatory power of square foot is not included in the $R^2$ value, thus this value appears artificially low. Re-computing the $R^2$ value in units of source energy[6], demonstrates that the equation actually explains 79.1% of the variation of source energy of offices. This is an excellent result for a statistically-based energy model.

Detailed information on the ordinary least squares regression approach is available in our Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARScore.

[6] The $R^2$ value in Source Energy is calculated as: 1 – (Residual Variation of Y) / (Total Variation of Y). The residual variation is sum of $(\text{Actual Source Energy}_i - \text{Predicted Source Energy}_i)^2$ across all observations. The Total variation of Y is the sum of $(\text{Actual Source Energy}_i - \text{Mean Source Energy})^2$ across all observations.

*Figure 2 - Descriptive Statistics for Variables in Final Regression Equation*

| Variable | Mean | Minimum | Maximum |
|---|---|---|---|
| Source EUI (kBtu/ft$^2$) | 198.4 | 19.62 | 1133 |
| Ln (Square Foot) | 9.535 | 8.517 | 13.82 |
| Number of Computers per 1000 ft$^2$ | 2.231 | 0.0273 | 11.11 |
| Ln (Weekly Operating Hours) | 3.972 | 3.611 | 5.124 |
| Ln (Number of Workers per 1000 ft$^2$) | 0.5616 | -3.882 | 2.651 |
| Heating Degree Days x Percent Heated | 4411 | 0.0000 | 9277 |
| Cooling Degree Days x Percent Cooled | 1157 | 0.0000 | 5204 |

*Figure 3 - Final Regression Results*

| Summary | | | | |
|---|---|---|---|---|
| Dependent Variable | Source Energy Intensity (kBtu/ft$^2$) | | | |
| Number of Observations in Analysis | 498 | | | |
| $R^2$ value | 0.3344 | | | |
| F Statistic | 22.19 | | | |
| Significance (p-level) | 0.0000 | | | |
| | Unstandardized Coefficients | Standard Error | T value | Significance (p-level) |
| Constant | 186.6 | 4.699 | 39.71 | 0.0000 |
| C_Ln (Square Foot) | 34.17 | 5.271 | 6.484 | 0.0000 |
| C_Number of Computers per 1000 ft$^2$ | 17.28 | 3.645 | 4.739 | 0.0000 |
| C_Ln (Weekly Operating Hours) | 55.96 | 13.53 | 4.135 | 0.0000 |
| C_Ln (Number of Workers per 1000 ft$^2$) | 10.34 | 7.304 | 1.416 | 0.1575 |
| C_HDD x Percent Heated | 0.0077 | 0.0026 | 2.962 | 0.0032 |
| C_CDD x Percent Cooled | 0.0144 | 0.0064 | 2.253 | 0.0249 |
| Small Bank x C_Ln (Square Foot) | -64.83 | 20.25 | -3.201 | 0.0015 |
| Small Bank x C_Ln(Number of Workers per 1000 ft$^2$) | 34.20 | 15.88 | 2.153 | 0.0318 |
| Small Bank | 56.30 | 15.01 | 3.751 | 0.0002 |

*Notes:*

- *The regression is a weighted ordinary least squares regression, weighted by the CBECS variable "ADJWT8".*
- *The prefix C_ on each variable indicates that it is centered. The centered variable is equal to difference between the actual value and the observed mean. The observed mean values are presented in Figure 2.*
- *Small bank is a yes/no variable (1 for yes, 0 for no) indicating whether the bank branch or financial office is 50,000 square foot or smaller in size.*
- *The final regression also included two variables to capture the effects of commercial and residential type refrigeration. These are included to ensure proper estimates for all other coefficients, but are not incorporated into the score for programmatic reasons, as discussed in the preceding text.*
- *The Ln (Square Foot) adjustment is capped at a maximum value of 200,000 square feet.*
- *The adjustment for computers is capped at a maximum value of 11.1 personal computers per 1000 square feet.*

## ENERGY STAR SCORE LOOKUP TABLE

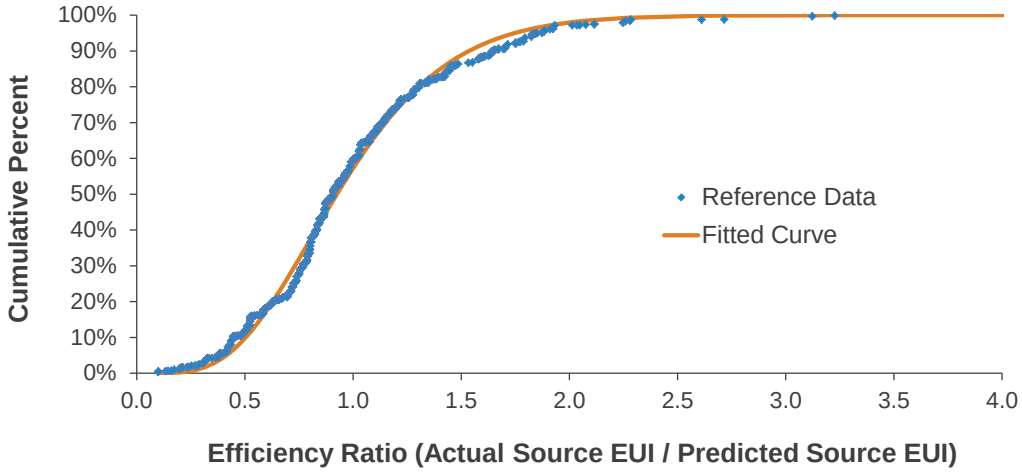
The final regression equation (presented in *Figure 3*) yields a prediction of source EUI based on a building's operating characteristics. Some buildings in the reference data sample use more energy than predicted by the regression equation, while others use less. The *actual* source EUI of each reference data observation is divided by its *predicted* source EUI to calculate an energy efficiency ratio:

$$Energy\ Efficiency\ Ratio = \frac{Actual\ Source\ EUI}{Predicted\ Source\ EUI}$$

A lower efficiency ratio indicates that a building uses less energy than predicted, and consequently is more efficient. A higher efficiency ratio indicates the opposite.

The efficiency ratios are sorted from smallest to largest and the cumulative percent of the population at each ratio is computed using the individual observation weights from the reference data set. *Figure 4* presents a plot of this cumulative distribution. A smooth curve (shown in orange) is fitted to the data using a two parameter gamma distribution. The fit is performed in order to minimize the sum of squared differences between each building's actual percent rank in the population and each building's percent rank with the gamma solution. The final fit for the gamma curve yielded a shape parameter (alpha) of 5.6456 and a scale parameter (beta) of 0.1741. For this fit, the sum of the squared error is 0.2673.

*Figure 4 – Distribution for Office*




The final gamma shape and scale parameters are used to calculate the efficiency ratio at each percentile (1 to 100) along the curve. For example, the ratio on the gamma curve at 1% corresponds to a score of 99; only 1% of the population has a ratio this small or smaller. The ratio on the gamma curve at the value of 25% will correspond to the ratio for a score of 75; only 25% of the population has ratios this small or smaller. The complete score lookup table is presented in *Figure 5*.

*Figure 5 – ENERGY STAR Score Lookup Table for Office*

| ENERGY STAR Score | Cumulative Percent | Energy Efficiency Ratio > = | Energy Efficiency Ratio < | ENERGY STAR Score | Cumulative Percent | Energy Efficiency Ratio >= | Energy Efficiency Ratio < |
|---|---|---|---|---|---|---|---|
| 100 | 0% | 0.0000 | 0.2628 | 50 | 50% | 0.8727 | 0.8822 |
| 99 | 1% | 0.2628 | 0.3097 | 49 | 51% | 0.8822 | 0.8917 |
| 98 | 2% | 0.3097 | 0.3424 | 48 | 52% | 0.8917 | 0.9013 |
| 97 | 3% | 0.3424 | 0.3686 | 47 | 53% | 0.9013 | 0.9111 |
| 96 | 4% | 0.3686 | 0.3909 | 46 | 54% | 0.9111 | 0.9209 |
| 95 | 5% | 0.3909 | 0.4107 | 45 | 55% | 0.9209 | 0.9308 |
| 94 | 6% | 0.4107 | 0.4286 | 44 | 56% | 0.9308 | 0.9408 |
| 93 | 7% | 0.4286 | 0.4452 | 43 | 57% | 0.9408 | 0.9509 |
| 92 | 8% | 0.4452 | 0.4606 | 42 | 58% | 0.9509 | 0.9612 |
| 91 | 9% | 0.4606 | 0.4751 | 41 | 59% | 0.9612 | 0.9716 |
| 90 | 10% | 0.4751 | 0.4889 | 40 | 60% | 0.9716 | 0.9821 |
| 89 | 11% | 0.4889 | 0.5020 | 39 | 61% | 0.9821 | 0.9928 |
| 88 | 12% | 0.5020 | 0.5146 | 38 | 62% | 0.9928 | 1.0037 |
| 87 | 13% | 0.5146 | 0.5268 | 37 | 63% | 1.0037 | 1.0147 |
| 86 | 14% | 0.5268 | 0.5386 | 36 | 64% | 1.0147 | 1.0260 |
| 85 | 15% | 0.5386 | 0.5500 | 35 | 65% | 1.0260 | 1.0374 |
| 84 | 16% | 0.5500 | 0.5612 | 34 | 66% | 1.0374 | 1.0490 |
| 83 | 17% | 0.5612 | 0.5721 | 33 | 67% | 1.0490 | 1.0609 |
| 82 | 18% | 0.5721 | 0.5827 | 32 | 68% | 1.0609 | 1.0730 |
| 81 | 19% | 0.5827 | 0.5931 | 31 | 69% | 1.0730 | 1.0854 |
| 80 | 20% | 0.5931 | 0.6034 | 30 | 70% | 1.0854 | 1.0980 |
| 79 | 21% | 0.6034 | 0.6135 | 29 | 71% | 1.0980 | 1.1110 |
| 78 | 22% | 0.6135 | 0.6234 | 28 | 72% | 1.1110 | 1.1243 |
| 77 | 23% | 0.6234 | 0.6332 | 27 | 73% | 1.1243 | 1.1380 |
| 76 | 24% | 0.6332 | 0.6429 | 26 | 74% | 1.1380 | 1.1520 |
| 75 | 25% | 0.6429 | 0.6525 | 25 | 75% | 1.1520 | 1.1664 |
| 74 | 26% | 0.6525 | 0.6619 | 24 | 76% | 1.1664 | 1.1814 |
| 73 | 27% | 0.6619 | 0.6713 | 23 | 77% | 1.1814 | 1.1968 |
| 72 | 28% | 0.6713 | 0.6807 | 22 | 78% | 1.1968 | 1.2127 |
| 71 | 29% | 0.6807 | 0.6899 | 21 | 79% | 1.2127 | 1.2293 |
| 70 | 30% | 0.6899 | 0.6991 | 20 | 80% | 1.2293 | 1.2465 |
| 69 | 31% | 0.6991 | 0.7083 | 19 | 81% | 1.2465 | 1.2644 |
| 68 | 32% | 0.7083 | 0.7174 | 18 | 82% | 1.2644 | 1.2831 |
| 67 | 33% | 0.7174 | 0.7265 | 17 | 83% | 1.2831 | 1.3028 |
| 66 | 34% | 0.7265 | 0.7356 | 16 | 84% | 1.3028 | 1.3235 |
| 65 | 35% | 0.7356 | 0.7446 | 15 | 85% | 1.3235 | 1.3453 |
| 64 | 36% | 0.7446 | 0.7537 | 14 | 86% | 1.3453 | 1.3685 |
| 63 | 37% | 0.7537 | 0.7627 | 13 | 87% | 1.3685 | 1.3933 |
| 62 | 38% | 0.7627 | 0.7717 | 12 | 88% | 1.3933 | 1.4198 |
| 61 | 39% | 0.7717 | 0.7808 | 11 | 89% | 1.4198 | 1.4485 |
| 60 | 40% | 0.7808 | 0.7898 | 10 | 90% | 1.4485 | 1.4798 |
| 59 | 41% | 0.7898 | 0.7989 | 9 | 91% | 1.4798 | 1.5143 |
| 58 | 42% | 0.7989 | 0.8080 | 8 | 92% | 1.5143 | 1.5528 |
| 57 | 43% | 0.8080 | 0.8171 | 7 | 93% | 1.5528 | 1.5966 |
| 56 | 44% | 0.8171 | 0.8262 | 6 | 94% | 1.5966 | 1.6474 |
| 55 | 45% | 0.8262 | 0.8354 | 5 | 95% | 1.6474 | 1.7084 |
| 54 | 46% | 0.8354 | 0.8447 | 4 | 96% | 1.7084 | 1.7854 |
| 53 | 47% | 0.8447 | 0.8539 | 3 | 97% | 1.7854 | 1.8910 |
| 52 | 48% | 0.8539 | 0.8633 | 2 | 98% | 1.8910 | 2.0653 |
| 51 | 49% | 0.8633 | 0.8727 | 1 | 99% | 2.0653 | >2.0653 |

## EXAMPLE CALCULATION

As detailed in our Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARScore, there are five steps to compute a score. The following is a specific example for the score for offices:

### 1 User enters building data into Portfolio Manager

- 12 months of energy use information for all energy types (annual values, entered in monthly meter entries)
- Physical building information (size, location, etc.) and use details describing building activity (hours, etc.)

| Energy Data | Value |
|---|---|
| Electricity | 3,500,000 kWh |
| Natural gas | 4,000 therms |

| Property Use Details | Value |
|---|---|
| Gross floor area (ft$^2$) | 200,000 |
| Weekly operating hours | 80 |
| Workers on the main shift[7] | 250 |
| Number of personal computers | 250 |
| Percent of the building that is heated | 100 % |
| Percent of the building that is cooled | 100 % |
| HDD (provided by Portfolio Manager, based on Zip code) | 4937 |
| CDD (provided by Portfolio Manager, based on Zip code) | 1046 |

### 2 Portfolio Manager computes the actual source EUI

- Total energy consumption for each fuel is converted from billing units into site energy and source energy
- Source energy values are added across all fuel types
- Source energy is divided by gross floor area to determine actual source EUI

*Computing Actual Source EUI*

| Fuel | Billing Units | Site kBtu Multiplier | Site kBtu | Source kBtu Multiplier | Source kBtu |
|---|---|---|---|---|---|
| Electricity | 3,500,000 kWh | 3.412 | 11,942,000 | 3.14 | 37,497,880 |
| Natural gas | 4,000 therms | 100 | 400,000 | 1.05 | 420,000 |
| | | | | Total Source Energy (kBtu) | 37,917,880 |
| | | | | Actual Source EUI (kBtu/ft$^2$) | 189.6 |

[7] This represents typical peak staffing level during the main shift. For example, in an office if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.

## 3 Portfolio Manager computes the predicted source EUI

- Using the property use details from Step 1, Portfolio Manager computes each building variable value in the regression equation (determining the natural log or density as necessary).
- The centering values are subtracted to compute the centered variable for each operating parameter.
- The centered variables are multiplied by the coefficients from the regression equation to obtain a predicted source EUI.

*Computing Predicted Source EUI*

| Variable | Actual Building Value | Reference Centering Value | Building Centered Variable | Coefficient | Coefficient * Centered Variable |
|---|---|---|---|---|---|
| Constant | -- | -- | -- | 186.6 | 186.6 |
| Ln (Square Foot) | 12.21 | 9.535 | 2.675 | 34.17 | 91.40 |
| Number of Computers per 1000 $ft^2$ | 1.250 | 2.231 | -0.9810 | 17.28 | -16.95 |
| Ln (Weekly Operating Hours) | 4.382 | 3.972 | 0.4100 | 55.96 | 22.94 |
| Ln (Number of Workers per 1000 $ft^2$) | 0.2230 | 0.5616 | -0.3386 | 10.34 | -3.501 |
| HDD x Percent Heated | 4937 | 4411 | 526.0 | 0.0077 | 4.050 |
| CDD x Percent Cooled | 1046 | 1157 | -111.0 | 0.0144 | -1.598 |
| Small Bank x Ln (Square Foot) | 0.0000 | NA | 0.0000 | -64.83 | 0.0000 |
| Small Bank x Ln (Number of Workers per 1000 $ft^2$) | 0.0000 | NA | 0.0000 | 34.20 | 0.0000 |
| Small Bank | 0.0000 | NA | 0.0000 | 56.30 | 0.0000 |
| | | | Predicted Source EUI (kBtu/$ft^2$) | | 282.9 |

## 4 Portfolio Manager computes the energy efficiency ratio

- The ratio equals the actual source EUI (Step 2) divided by predicted source EUI (Step 3)
- Ratio = 189.6 / 282.9 = 0.6702

## 5 Portfolio Manager uses the efficiency ratio to assign a score via a lookup table

- The ratio from Step 4 is used to identify the score from the lookup table
- A ratio of 0.6702 is greater than or equal to 0.6619 and less than 0.6713.
- *The ENERGY STAR score is 73.*