ENERGY STAR

Portfolio Manager Technical Reference

# ENERGY STAR Score for Offices in Canada

## OVERVIEW

The ENERGY STAR Score for Offices applies to office and financial office 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. A statistical analysis of the peer building population is performed to identify the aspects of building activity that are significant drivers of energy use and then to normalize for those factors. 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 two property types: office and financial office. The score applies to individual buildings only and is not available for campuses.
- **Reference data.** The analysis for offices in Canada is based on data from the Survey on Commercial and Institutional Energy Use (SCIEU), which was commissioned by Natural Resources Canada (NRCan) and carried out by Statistics Canada.
- **Adjustments for weather and business activity.** The analysis includes adjustments for:
    - Building size
    - Number of computers
    - Number of workers
    - Hours of operation per week
    - Weather and climate (using heating and cooling degree days, retrieved based on postal code)
    - Percent of the building that is heated and cooled
- **Release date.** This is the first release of the ENERGY STAR score for offices using Canadian data.

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 http://www.energystar.gov/ENERGYSTARScore. The subsequent sections of this document offer specific details on the development of the ENERGY STAR score for offices:

## REFERENCE DATA & FILTERS

For the ENERGY STAR score for office properties in Canada, the reference data used to establish the peer building population is based on data from the Survey on Commercial and Institutional Energy Use (SCIEU), which was commissioned by Natural Resources Canada and carried out by Statistics Canada in late 2010 and early 2011. The consumption data for the survey was from the calendar year 2009. The raw collected data file for this survey is not publically available, but a report providing summary results is available on Natural Resources Canada's website at http://oee.nrcan.gc.ca/publications/statistics/scieu09/scieu_e.pdf.

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 and the rationale behind the filter. After all filters are applied, the remaining data set has 434 observations. Due to the confidentiality of the survey data, we were not able to identify the number of cases after each filter.

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

| Condition for Including an Observation in the Analysis | Rationale |
|---|---|
| Defined as category 1 in SCIEU – Office Building | The SCIEU survey covered the commercial and institutional sector and included buildings of all types. For this model, only the observations identified as primarily office buildings are used. |
| Building must be at least 70% Office | Building Type Filter – Definition of an Office |
| Must have electric energy data | Program Filter – Basic requirement to be considered a functioning office is that it requires electrical consumption. Electricity can be grid-purchased or produced on-site. |
| Must have 70% of the area that is heated | Program Filter – Basic requirement to be a functioning office |
| Must operate at least 30 hours per week | Program Filter – Basic requirement to be considered as full-time operation |
| Must have at least 1 person | Program Filter – Basic requirement for a functioning office: it must be occupied |
| Must have at least 1 computer | Program Filter – Basic requirement for a functioning office: it must have at least one computer |
| Must operate at least 10 months per year | Program Filter – Basic requirement to be considered as full-time operation |
| Must not use any "other" fuels for which the consumption is not reported | Data Limitation Filter – No data collected on this consumption. The survey asked if additional energy consumption occurred in the building that was not reported. In those occurrences, the cases were removed from the analysis. |
| Must be built in 2008 or earlier | Data Limitation Filter – The survey reported the consumption for calendar year 2009. Therefore, if the building was being built in 2009, a full year of consumption data would not be available. |
| Must not include energy supplied to other buildings that was not quantified | Data Limitation Filter – No data collected on this consumption if the respondent identified that the building supplied energy to other buildings but did not provide the amount. |
| Must be at least 465 $m^2$ (5000 $ft^2$) | Analytical Filter – Analysis could not model behaviours for buildings smaller than 465 $m^2$ (5000 $ft^2$). |

| Condition for Including an Observation in the Analysis | Rationale |
|---|---|
| Must have Source EUI that is greater than 0.4 and less than 7 $GJ/m^2$ | Analytical Filter – Values determined to be outliers based on analysis of the data. Outliers are typically clearly outside normal operating parameters for a building of this type. |
| Must have an occupant density (occupants per 100 $m^2$) that is greater than or equal to 0.25 and less than or equal to 25 | Analytical Filter – Values determined to be outliers based on analysis of the data. Outliers are typically clearly outside normal operating parameters for a building of this type. |
| Cannot have more than 3 computers per person | Analytical Filter – Values determined to be outliers. Computer was defined as desktop computers or laptops. Does not include smart phones, tablets or other small mobile devices. |
| Cannot have a computer server density of more than 4 per 100 $m^2$ | Analytical Filter - Values determined to be outliers based on analysis of the data. Outliers are typically clearly outside normal operating parameters for a building of this type. |
| Cannot have more than 10% of the floor space dedicated to commercial cooking | Analytical Filter – Values determined to be outliers based on analysis of the data. Outliers are typically clearly outside normal operating parameter for a building of this type. |

The goal of this analysis was to be representative of a typical office building being used for commercial and institutional purposes. An in-depth analysis was performed to evaluate the minimum size at 100 m² intervals. The analysis showed that for buildings below the threshold of 465 m², the behaviour was significantly more varied and did not follow the general trends of larger buildings. Interestingly, that threshold corresponds to the minimum size (5000 $ft^2$) found in the analysis for offices in the United-States. Also, that cut-off was evaluated because square footage is still commonly used in Canada, and there were a noticeable number of cases at the 5,000 ft² size. Therefore, in order for the analysis to accurately fit the targeted office building, a minimum floor space of 465 m² was selected, which is equivalent to the 5,000 ft² seen in the U.S. analysis.

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 behaviour from the rest of the properties (i.e., office buildings smaller than 465 $m^2$ 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 meter in offices. The unit for source EUI in the Canadian model is the Gigajoule per Square Meter (GJ/m$^2$)

### Independent Variables

The SCIEU data contains numerous building operation questions that NRCan identified as potentially important for offices. Based on a review of the available variables in the SCIEU data, in accordance with the criteria for inclusion,[1] NRCan initially analyzed the following variables in the regression analysis:

- Gross building area (m$^2$)
- Heating degree days (HDD)
- Cooling degree days (CDD)
- Average outdoor temperature (°C)
- Percentage of heated floor space
- Percentage of cooled floor space
- Presence of commercial food preparation area (Y/N)
- Floor space dedicated to commercial cooking area
- Year of construction
- Presence of an indoor pool (Y/N)
- Number of floors
- Number of elevators
- Number of escalators
- Weekly hours of operation
- Months in operation in 2009
- Number of workers on the main shift
- Number of computers
- Number of computer servers
- Number of vending machines
- Floor space that is interior parking

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

- Floor space that is heated interior parking
- Presence of associated exterior parking

NRCan and EPA performed extensive review on all of these operational characteristics. In addition to reviewing each characteristic individually, characteristics were reviewed in combination with each other (e.g., Heating Degree Days times Percent Heated). As part of the analysis, some variables were 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 meter* (not the gross number of workers) is expected to be correlated with the energy use per square meter. Also, based on analytical results and residual plots, variables were 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:

- Weekly hours of operation
- Number of workers per 100 $m^2$ during main shift
- Number of computers and servers per 100 $m^2$
- Building floor area [note 2]
- Natural logarithm of building floor area [note 2]
- Heating degree days
- Natural logarithm of cooling degree days times percent cooled [note 3]

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

### Occupants and Computers

It was noted that there was a correlation between the number of computers and the number of occupants, which is expected in an office environment. NRCan analyzed several combinations of variables using computers and occupants including: number of occupants per 100 $m^2$; number of computers per 100 $m^2$ and number of computers per occupant. While all these variables proved to be significant in certain combinations, the most appropriate equation was deemed to have the number of occupants per 100 $m^2$ and the number of computers per 100 $m^2$ in it. The number of computers and the number of servers were also considered separately but their combination in one variable showed a higher significance in the equation. Moreover, that combination is easier to manage for users of Portfolio Manager.

### Climate (HDD and CDD)

The analysis looked at the heating degree days (HDD), the cooling degree days (CDD) and the average outdoor temperature. In addition, the product of HDD and percent heated, as well as CDD and percent cooled were also investigated. The initial finding was that the CDD terms were not consistently showing as either significant or with a positive coefficient. This was likely due to the much narrower range of cooling degree days across Canada compared to what is typical in the U.S. Therefore, the CDD variables were given a closer look, and the variable that came out

[2] Both Area variables are subject to a maximum value; see detailed description below.
[3] If building is not cooled, this variable is given a value of 0 even if Ln(0) is undefined.

consistently significant was the percent cooled multiplied by the natural logarithm of CDD. As such, this variable was selected to be incorporated in the equation. Similarly, with regard to the HDD, while HDD times percent heated was significant, the regression performed slightly better with HDD only and not multiplied by the percent heated. This is likely due to the fact that most Canadian buildings are, in practice, fully heated, and the few cases that were not heated were likely not as common. An analysis performed on the average temperature did not yield better results and was therefore not considered.

Another important note with regard to climate is that the range between the minimum and maximum for both HDD and CDD in Canada is typically much smaller than in the U.S. Since the large majority of the Canadian population is located in the southern part of the country, the difference between the maximum and minimum values for HDD and CDD is much smaller than what was seen in the U.S. data. Whereas the differences in HDD/CDD between cities like Miami and Minneapolis, for example, produce a large relative difference of HDD (110 vs. 4400) and CDD (2332 vs. 380), this is not seen commonly in the Canadian data model even when comparing cities like Toronto and Edmonton with HDD (3600 vs. 5700) and CDD (350 vs. 25).

The weather data for the Canadian buildings was taken from the U.S. National Climatic Data Center source which is the same source used by EPA for U.S. buildings. The U.S. National Climatic Data Center tracks data from weather stations across the world. This is also the source of weather data in Portfolio Manager.

### Property Size and Number of Floors

Several variables that were related to the size of the building were identified for further analysis. They included the area, natural logarithm of area, number of floors, number of elevators and number of escalators. The strongest variable that was consistently significant was the natural logarithm of area (LnArea). This variable was always significant on its own. However, we also noted that if LnArea was present, the Area variable became significant with a negative coefficient. This was seen as a moderating variable against the LnArea. It is important to note that neither number of floors nor area variables were significant on their own or when both were included in the regression.

The number of elevators and escalators were not significant and did not improve the quality of the regression. In addition, since some buildings' architectural features have the floor plate size getting smaller in the top floors, the area per floor variable was seen as potentially confusing and was not included in the regression. The final equation includes LnArea and Area.

In addition, it was noticed that the correlation between consumption and size of building disappeared for offices larger than 5,000 $m^2$. As a result, the adjustment applied for LnArea and area stays uniform for buildings larger than 5,000 $m^2$. This was likely due to the fact that 5,000 $m^2$ (approximately 54,000 $ft^2$) is the threshold where buildings tend to switch to the more central heating and cooling systems seen in larger buildings. As a result, the correlation between size and consumption intensity was no longer present and was therefore not needed. This means that for buildings larger than 5,000 $m^2$, the equation to predict energy consumption uses the value of 5,000 $m^2$, as can be seen in the example further below.

### Testing

Finally, NRCan tested the regression equation using actual office buildings that have been entered in Portfolio Manager. This provided another set of buildings to examine in addition to the SCIEU data, to see the average ENERGY STAR scores and distributions, and to assess the impacts and adjustments. This analysis provided a second level of confirmation that the final regression equation produced robust results that are unbiased with respect to the key operational characteristics such as building size, computer density, worker density, and heating and cooling degree days. It also confirmed that there was no regional bias or bias for the type of energy used for heating.

It is important to reiterate that the final regression equation is based on the nationally representative reference data, not on 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 434 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 their respective significance level.

The regression equation has a coefficient of determination ($R^2$) value of 0.323, indicating that this equation explains 32.3% of the variance in source EUI for office buildings. Because the final equation is structured with energy per unit area as the dependent variable, the explanatory power of the area is not included in the $R^2$ value, and thus this value appears artificially low. Re-computing the $R^2$ value in units of source energy[4] demonstrates that the equation actually explains 83.9% of the variation in total 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.

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

| Variable | Mean | Minimum | Maximum |
|---|---|---|---|
| Source energy per $m^2$ ($GJ/m^2$) | 1.788 | 0.4 | 6.64 |
| Weekly hours of operation | 57.95 | 34 | 168 |
| Number of workers per 100 $m^2$ during main shift | 3.492 | 0.3012 | 19.24 |
| Number of computers and computer servers per 100 $m^2$ | 3.335 | 0.0828 | 15.5844 |
| Natural logarithm of building floor area | 7.360 | 6.142 | 12.5357 |
| Building floor area | 2933 | 465 | 278101 |
| Heating degree days | 4619 | 2947.4 | 7322.5 |
| Percent cooled times natural logarithm of cooling degree days | 3.703 | 0 | 5.9908 |

[4] The $R^2$ value in Source Energy is calculated as: 1 – (Residual Variation of Y) / (Total Variation of Y). The residual variation is the 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 3 - Final Regression Results***

| Summary | | | | |
|---|---|---|---|---|
| Dependent variable | Source Energy Intensity (GJ/m$^2$) | | | |
| Number of observations in analysis | 434 | | | |
| $R^2$ value | 0.323 | | | |
| F statistic | 26.62 | | | |
| Significance (p-level) | 0.0000 | | | |
| | **Unstandardized Coefficients** | **Standard Error** | **T Value** | **Significance (p-level)** |
| Constant | 1.788 | 0.030 | 58.736 | 0.000 |
| C_Weekly Hours of Operation | 0.006325 | 0.001 | 5.595 | 0.000 |
| C_Number of Workers per 100 m$^2$ | 0.06546 | 0.018 | 3.639 | 0.000 |
| C_Number of Computers and Servers per 100 m$^2$ | 0.07455 | 0.019 | 3.829 | 0.000 |
| C_Ln(Building Floor Area) | 0.3643 | 0.048 | 7.548 | 0.000 |
| C_Building Floor Area | -2.596E-05 | 0.000 | -3.492 | 0.001 |
| C_Heating Degree days | 2.034E-04 | 0.000 | 6.059 | 0.000 |
| C_Percent Cooled times Ln(Cooling Degree days) | 0.06386 | 0.023 | 2.719 | 0.007 |

*Notes:*
- *The regression is a weighted ordinary least squares regression, weighted by the SCIEU variable “WTBS.”*
- *The prefix C_ on each variable indicates that it is centered. The centered variable is equal to the difference between the actual value and the observed mean. The observed mean values are presented in Figure 2.*
- *Weekly hours of operation are hours on the main shift only.*
- *The area variable is capped at a maximum value of 5,000 m$^2$.*
- *The heating degree days and cooling degree days are sourced from the U.S. National Climatic Data Center*

## ENERGY STAR SCORE LOOKUP TABLE

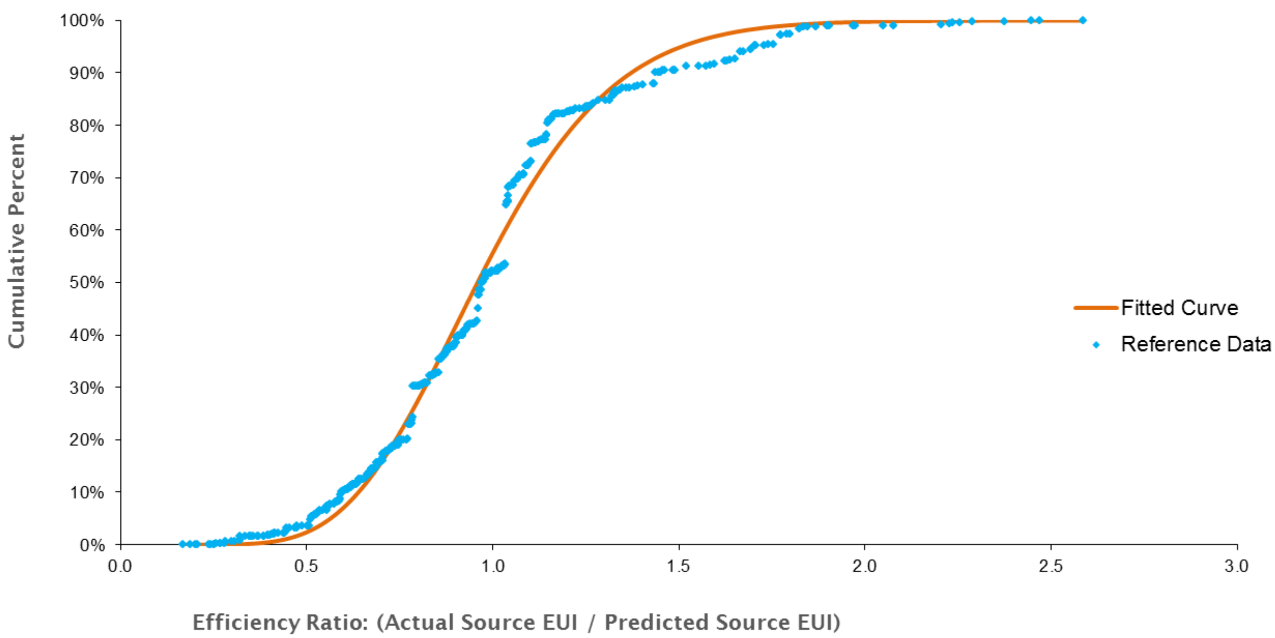
The final regression equation (presented in ***Figure 3***) yields a prediction of source EUI based on a building’s operating characteristics. Some buildings in the SCIEU data sample use more energy than predicted by the regression equation, while others use less. The *actual* source EUI of each reference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

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

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 11.6318 and a scale parameter (beta) of 0.08484. For this fit, the sum of the squared error is 0.45628.

***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 a ratio 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 | |
|---|---|---|---|
| | | > = | < |
| 100 | 0% | 0.0000 | 0.4400 |
| 99 | 1% | 0.4400 | 0.4870 |
| 98 | 2% | 0.4870 | 0.5186 |
| 97 | 3% | 0.5186 | 0.5433 |
| 96 | 4% | 0.5433 | 0.5639 |
| 95 | 5% | 0.5639 | 0.5820 |
| 94 | 6% | 0.5820 | 0.5981 |
| 93 | 7% | 0.5981 | 0.6128 |
| 92 | 8% | 0.6128 | 0.6264 |
| 91 | 9% | 0.6264 | 0.6391 |
| 90 | 10% | 0.6391 | 0.6511 |
| 89 | 11% | 0.6511 | 0.6624 |
| 88 | 12% | 0.6624 | 0.6732 |
| 87 | 13% | 0.6732 | 0.6836 |
| 86 | 14% | 0.6836 | 0.6936 |
| 85 | 15% | 0.6936 | 0.7032 |
| 84 | 16% | 0.7032 | 0.7125 |
| 83 | 17% | 0.7125 | 0.7216 |
| 82 | 18% | 0.7216 | 0.7304 |
| 81 | 19% | 0.7304 | 0.7391 |
| 80 | 20% | 0.7391 | 0.7475 |
| 79 | 21% | 0.7475 | 0.7558 |
| 78 | 22% | 0.7558 | 0.7639 |
| 77 | 23% | 0.7639 | 0.7718 |
| 76 | 24% | 0.7718 | 0.7797 |
| 75 | 25% | 0.7797 | 0.7874 |
| 74 | 26% | 0.7874 | 0.7951 |
| 73 | 27% | 0.7951 | 0.8026 |
| 72 | 28% | 0.8026 | 0.8101 |
| 71 | 29% | 0.8101 | 0.8174 |
| 70 | 30% | 0.8174 | 0.8248 |
| 69 | 31% | 0.8248 | 0.8320 |
| 68 | 32% | 0.8320 | 0.8392 |
| 67 | 33% | 0.8392 | 0.8464 |
| 66 | 34% | 0.8464 | 0.8535 |
| 65 | 35% | 0.8535 | 0.8606 |
| 64 | 36% | 0.8606 | 0.8677 |
| 63 | 37% | 0.8677 | 0.8747 |
| 62 | 38% | 0.8747 | 0.8817 |
| 61 | 39% | 0.8817 | 0.8887 |
| 60 | 40% | 0.8887 | 0.8957 |
| 59 | 41% | 0.8957 | 0.9027 |
| 58 | 42% | 0.9027 | 0.9097 |
| 57 | 43% | 0.9097 | 0.9167 |
| 56 | 44% | 0.9167 | 0.9237 |
| 55 | 45% | 0.9237 | 0.9307 |
| 54 | 46% | 0.9307 | 0.9378 |
| 53 | 47% | 0.9378 | 0.9448 |
| 52 | 48% | 0.9448 | 0.9519 |
| 51 | 49% | 0.9519 | 0.9590 |

| ENERGY STAR Score | Cumulative Percent | Energy Efficiency Ratio | |
|---|---|---|---|
| | | >= | < |
| 50 | 50% | 0.9590 | 0.9662 |
| 49 | 51% | 0.9662 | 0.9734 |
| 48 | 52% | 0.9734 | 0.9806 |
| 47 | 53% | 0.9806 | 0.9879 |
| 46 | 54% | 0.9879 | 0.9952 |
| 45 | 55% | 0.9952 | 1.0026 |
| 44 | 56% | 1.0026 | 1.0101 |
| 43 | 57% | 1.0101 | 1.0176 |
| 42 | 58% | 1.0176 | 1.0252 |
| 41 | 59% | 1.0252 | 1.0329 |
| 40 | 60% | 1.0329 | 1.0407 |
| 39 | 61% | 1.0407 | 1.0486 |
| 38 | 62% | 1.0486 | 1.0566 |
| 37 | 63% | 1.0566 | 1.0647 |
| 36 | 64% | 1.0647 | 1.0729 |
| 35 | 65% | 1.0729 | 1.0812 |
| 34 | 66% | 1.0812 | 1.0897 |
| 33 | 67% | 1.0897 | 1.0984 |
| 32 | 68% | 1.0984 | 1.1072 |
| 31 | 69% | 1.1072 | 1.1161 |
| 30 | 70% | 1.1161 | 1.1253 |
| 29 | 71% | 1.1253 | 1.1346 |
| 28 | 72% | 1.1346 | 1.1442 |
| 27 | 73% | 1.1442 | 1.1540 |
| 26 | 74% | 1.1540 | 1.1640 |
| 25 | 75% | 1.1640 | 1.1743 |
| 24 | 76% | 1.1743 | 1.1850 |
| 23 | 77% | 1.1850 | 1.1959 |
| 22 | 78% | 1.1959 | 1.2072 |
| 21 | 79% | 1.2072 | 1.2189 |
| 20 | 80% | 1.2189 | 1.2311 |
| 19 | 81% | 1.2311 | 1.2437 |
| 18 | 82% | 1.2437 | 1.2568 |
| 17 | 83% | 1.2568 | 1.2706 |
| 16 | 84% | 1.2706 | 1.2850 |
| 15 | 85% | 1.2850 | 1.3003 |
| 14 | 86% | 1.3003 | 1.3163 |
| 13 | 87% | 1.3163 | 1.3335 |
| 12 | 88% | 1.3335 | 1.3518 |
| 11 | 89% | 1.3518 | 1.3715 |
| 10 | 90% | 1.3715 | 1.3929 |
| 9 | 91% | 1.3929 | 1.4164 |
| 8 | 92% | 1.4164 | 1.4426 |
| 7 | 93% | 1.4426 | 1.4722 |
| 6 | 94% | 1.4722 | 1.5064 |
| 5 | 95% | 1.5064 | 1.5473 |
| 4 | 96% | 1.5473 | 1.5985 |
| 3 | 97% | 1.5985 | 1.6682 |
| 2 | 98% | 1.6682 | 1.7819 |
| 1 | 99% | 1.7819 | >1.7819 |

## EXAMPLE CALCULATION

As detailed in the Technical Reference for the ENERGY STAR Score, http://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 | 3,000,000 kWh |
| Natural gas | 200,000 $m^3$ |

| Property Use Details | Value |
|---|---|
| Gross floor area ($m^2$) | 20,000 |
| Weekly operating hours | 80 |
| Workers on the main shift[5] | 250 |
| Number of personal computers | 250 |
| Number of computer servers | 5 |
| Percent heated | 100 % |
| Percent cooled | 100 % |
| HDD (provided by Portfolio Manager, based on postal code) | 3600 |
| CDD (provided by Portfolio Manager, based on postal code) | 425 |

### 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 GJ Multiplier | Site GJ | Source Multiplier | Source GJ |
|---|---|---|---|---|---|
| Electricity | 3,000,000 kWh | 0.0036 | 10,800 | 2.05 | 22,140 |
| Natural gas | 200,000 $m^3$ | 0.03843 | 7,686 | 1.02 | 7,840 |
| | | | | Total Source Energy (GJ) | 29,980 |
| | | | | **Actual Source EUI (GJ/m²)** | **1.499** |

[5] This represents the 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 logarithm 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 office regression equation to obtain a predicted source EUI.

***Computing Predicted Source EUI***

| Variable | Actual Building Value | Reference Centering Value | Building Centered Variable | Coefficient | Coefficient x Centered Variable |
|---|---|---|---|---|---|
| Constant | - | - | - | 1.788 | 1.788 |
| C_Weekly Hours of Operation | 80 | 57.95 | 22.05 | 0.006325 | 0.139 |
| C_Number of Workers per 100 $m^2$ | 1.25 | 3.49 | -2.24 | 0.06546 | -0.147 |
| C_Number of Computers and Servers per 100 $m^2$ | 1.275 | 3.34 | -2.06 | 0.07455 | -0.154 |
| C_Ln(Building Floor Area) | 8.517 | 7.36 | 1.16 | 0.3643 | 0.422 |
| C_Building Floor Area | 5,000 | 2,933 | 2,067 | -2.60E-05 | -0.054 |
| C_Heating Degree days | 3,600 | 4,619 | -1,019 | 2.03E-04 | -0.207 |
| C_Percent Cooled x Ln(Cooling Degree days) | 6.052 | 3.70 | 2.35 | 0.06386 | 0.150 |
| | | | ***Predicted Source EUI (GJ/$m^2$)*** | | **1.938** |

## 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 = 1.499 / 1.938 = 0.7736

## 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 0.7736 is less than 0.7797 (requirement for 76) but greater than 0.7718 (requirement for 77).
- ***The ENERGY STAR score is 76.***