ENERGY STAR® PortfolioManager® Technical Reference

ENERGY STAR Score for Senior Care Communities and Residential Care Facilities in Canada

OVERVIEW

The ENERGY STAR Score for Senior Care Communities and Residential Care Facilities in Canada applies to facilities that provide permanent rehabilitative, restorative and/or ongoing skilled nursing care to patients or residents in need of assistance with activities of daily living. Residential care facilities include nursing homes and residential developmental handicap, mental health and substance abuse facilities. 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 predicts 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 senior care communities and residential care facilities in Canada applies to properties that provide permanent rehabilitative, restorative and/or ongoing skilled nursing care to patients or residents in need of assistance with activities of daily living. The ENERGY STAR score applies to entire senior care communities or residential care facilities, whether they are single buildings or campuses of buildings.
- **Reference data.** The analysis for senior and residential care in Canada is based on data from the *Survey of Commercial and Institutional Energy Use* (SCIEU), which was commissioned by Natural Resources Canada (NRCan) and carried out by Statistics Canada, and represents the energy consumption year 2009.
- **Adjustments for weather and business activity.** The analysis includes adjustments for:
  - Licensed bed capacity
  - Number of workers on the main shift
  - Weather and climate (using heating and cooling degree days, retrieved based on postal code)
  - Percent of the building that is cooled
- **Release date.** This is the first release of the ENERGY STAR Score for Senior Care Communities and Residential Care Facilities in Canada.

This document presents details on the development of the 1 – 100 ENERGY STAR score for senior care communities and residential care facilities. 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 senior care communities and residential care facilities:

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REFERENCE DATA & FILTERS

The ENERGY STAR score for senior care communities and residential care facilities in Canada applies to facilities that provide permanent rehabilitative, restorative and/or ongoing skilled nursing care to patients or residents in need of assistance with activities of daily living. Long-term care facilities include nursing homes and residential developmental handicap, mental health and substance abuse facilities. Purely residential retirement homes are not included in this category. The reference data used to establish the peer building population is based on data from the *Survey of 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 energy 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 were 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 senior care communities and residential care facilities and the rationale behind the filter. After all filters were applied, the remaining data set has 142 observations. Due to the confidentiality of the survey data, NRCan is not able to identify the number of cases after each filter.

Figure 1 – Summary of Filters for the ENERGY STAR Score for Senior Care Communities and Residential Care Facilities

Condition for Including an Observation in the Analysis	Rationale
Defined as category 4 in SCIEU – Nursing and Residential Care Facility	The SCIEU covered the commercial and institutional sector and included buildings of all types. For this model, only the observations identified with a main activity of senior care communities and residential care were used.
Building must be at least 50% senior care communities and residential care	Building Type Filter – In order to be considered part of the senior care communities and residential care peer group, more than 50% of the building must be senior care community or residential care.
Must have electric energy data	Program Filter – Basic requirement to be considered a senior care community or residential care facility is that it requires electrical energy. Electricity can be grid-purchased or produced on site.
Must operate 12 months per year	Program Filter – Basic requirement to be considered as full time operation for this building type.
Must operate 168 hours per week	Program Filter – Basic requirement to be considered as full time operation for this building type.
Must have at least 1 worker	Program Filter – Basic requirement for a functioning senior care community or residential care facility. There must be at least one worker during the main shift.
Must have at least 5 licensed beds	Program Filter – Basic requirement for a functioning senior care community or residential care facility. There must be at least five licensed care beds.
Must be built in 2008 or earlier	Data Limitation Filter – The survey reported the energy for calendar year 2009. Therefore, if the building was being built in 2009, a full year of energy data would not be available.

Condition for Including an Observation in the Analysis	Rationale
Must not use any "other" fuels for which the energy is not reported	Data Limitation Filter – No data collected on this energy. 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 at least 550 m^2	Analytical Filter – The analysis could not model behaviour of buildings smaller than 550 m^2 (approximately 6000 ft^2).
Source EUI must be greater than 0.5 and less than 4.5 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 a bed-to-worker ratio of less than 8.5	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.

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 available during the analysis, 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 has a different behaviour from the rest of the properties (e.g., senior care communities and residential care facilities that are smaller than 550 m^2 do not behave the same way as larger buildings), in which case an Analytical Filter is 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 part of a building, a single building, or a campus of buildings. The applicability of the ENERGY STAR score depends on the type of property. For senior care communities and residential care facilities, the score is available for properties that are single buildings or a campus of buildings. It is important to note that for properties that earn a campus score, the entire campus will receive a 1-100 score, and individual buildings on the campus cannot earn separate scores.

VARIABLES ANALYZED

To normalize for differences in business activity, a statistical analysis was performed to understand what aspects of building activity are significant with respect to energy use. The filtered reference data set, described in the previous section, was analyzed using a weighted ordinary least squares regression, which evaluated energy use relative to business activity (e.g. number of licensed beds, number of workers, and climate). This linear regression yielded 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 of senior care communities and residential care facilities in Canada.

Dependent Variable

The dependent variable is what we try to predict with the regression equation. For the senior care communities and residential care facilities 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 regression analyzes the key drivers of source EUI – those factors that explain the variation in source energy use per square metre in senior care communities and residential care facilities. The unit for source EUI in the Canadian model is the gigajoule per square metre (GJ/m^2) per year.

Independent Variables

The SCIEU data contains numerous building property attributes that NRCan identified as potentially important for senior care communities and residential care facilities. 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 floor space that is heated
- Percentage of floor space that is cooled
- Number of workers during the main shift
- Number of computers and computer servers
- Number of floors
- Number of elevators and escalators
- Number of medical diagnosis and treatment machines
- Number representing the licensed bed capacity
- Presence of commercial food preparation area (y/n)
- Presence of on-site laundry facilities (y/n)
- Floor space that is interior parking
- Floor space that is heated interior parking
- Presence of associated exterior parking (y/n)

NRCan and EPA performed extensive review on all of these operational characteristics. In addition to reviewing each characteristic individually, certain 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 can be evaluated in a density format such as the number of workers *per square metre* (as opposed to the gross number of workers) and could be expected to be correlated with the energy use per square metre. 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.

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

The final regression equation includes the following variables:

- Number of workers per 100 m^2 during main shift
- Number of licensed care beds per 100 m^2
- Number of heating degree days (HDD)
- Number of cooling degree days times percent of the building that is cooled (% cooled x CDD)

These variables are used together to compute the predicted source EUI for senior care communities and residential care facilities. The predicted source EUI 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 that operate like your building.

Climate (HDD and CDD)

The analysis looked at the Heating Degree Days (HDD), Cooling Degree Days (CDD), percent of the building that is heated, and percent of the building that is cooled. There was a strong correlation between the EUI of the building and the HDD observed by the building. During the analysis, HDD was also analyzed in combination with the percent of the building that is heated. However, for this building type, the vast majority of buildings were 100% heated and therefore the variable "HDD x % heated" did not yield a statistically better outcome. As a result, the variable included in the model is HDD.

With regard to the CDD variable, the analysis indicated that a noticeable portion of the regression sample observations did not have air conditioning, resulting in lower EUI on average. As a result, multiplying the CDD by the percent of the building that is cooled (% cooled) resulted in a variable (% cooled x CDD) that was a consistently significant predictor of source EUI.

The weather data for the Canadian model was taken from the U.S. National Climatic Data Center, which has 152 Canadian weather stations. This is also the source of weather data for Portfolio Manager. The weather data is associated to the building using the closest Canadian weather station based on the postal code of the building.

Property Floor Area

The analysis indicated that very small buildings did not behave the same way as the majority of the observations. Small buildings had a very wide range of energy use intensities that were difficult to model with the available predictor variables. For this reason, it was necessary to exclude buildings less than 550 m^2 from the analysis in order to establish a consistent statistical model for the remainder of the population. For this reason, buildings smaller than 550 m^2 are not eligible to receive an ENERGY STAR score.

Number of workers and number of licensed beds

The worker density (workers per 100 m^2) was highly significant during the development of the senior and residential care facilities model. However, the inclusion of observations with bed-to-worker ratios higher than 8.5 workers/bed resulted in unstable models. For these reasons, it was necessary to apply filters at each of the thresholds described above in order to remove outliers from the regression data set. In Portfolio Manager, buildings exceeding these thresholds may still receive an ENERGY STAR score.

Testing

Finally, NRCan further analyzed the regression equation using actual data that has been entered in Portfolio Manager. This provided another set of buildings to examine, in addition to the SCIEU data, to see the ENERGY STAR scores and distributions, and to assess the impacts and adjustments. This analysis on a separate data set provided a second level of verification to ensure that there was a good distribution of scores.

It is important to reiterate that the final regression equation is based on nationally representative reference data from SCIEU 2009, 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 142 observations. The dependent variable is Source EUI. Each independent variable is centered relative to the weighted 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 levels.

The regression equation has a coefficient of determination (R^2) value of 0.206, indicating that this equation explains 20.6% of the variance in source EUI for senior care communities and residential care 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[2] demonstrates that the equation actually explains 86.1% of the variation in total source energy of senior care communities and residential care facilities. 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.

[2] 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 (Actual Source Energy$_i$ – Predicted Source Energy$_i$)^2 across all observations. The total variation of Y is the sum of (Actual Source Energy$_i$ – Mean Source Energy)^2 across all observations.

Figure 2 - Descriptive Statistics for Variables in Final Regression Equation

Variable	Median	Minimum	Maximum	Centering
Source energy per square metre (GJ/m²)	2.07274	0.57325	4.14539	2.01224
Heating degree days	4581	3068	7322	4659
Cooling degree days x percent cooled	70.22	0.00	399.72	76.35
Number of workers per 100 m² during main shift	0.60132	0.08392	3.34848	0.71471
Number of beds per 100 m²	1.565	0.205	5.692	1.703

Figure 3 - Final Regression Results

Summary				
Dependent variable		Source energy use intensity (GJ/m²)		
Number of observations in analysis		142		
R^2 value		0.206		
Adjusted R^2 value		0.183		
F statistic		8.89		
Significance (p-level)		< 0.0001		
	Unstandardized Coefficients	**Standard Error**	**T Value**	**Significance (p-level)**
Constant	2.01224	0.04958	40.58	<0.0001
C_Heating degree days	0.00018547	0.00006915	2.68	0.0082
C_Cooling degree days x percent cooled	0.00208	0.00079745	2.61	0.0100
C_Number of workers per 100 m²	0.32689	0.12452	2.63	0.0096
C_Number of beds per 100 m²	0.14543	0.06748	2.16	0.0329

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 centred. The centred variable is equal to difference between the actual value and the observed mean. The observed mean values (i.e. centering terms) are presented in Figure 2.*
- *Heating and cooling degree days are sourced from Canadian weather stations included in the U.S. National Climatic Data Center system*

ENERGY STAR SCORE LOOKUP TABLE

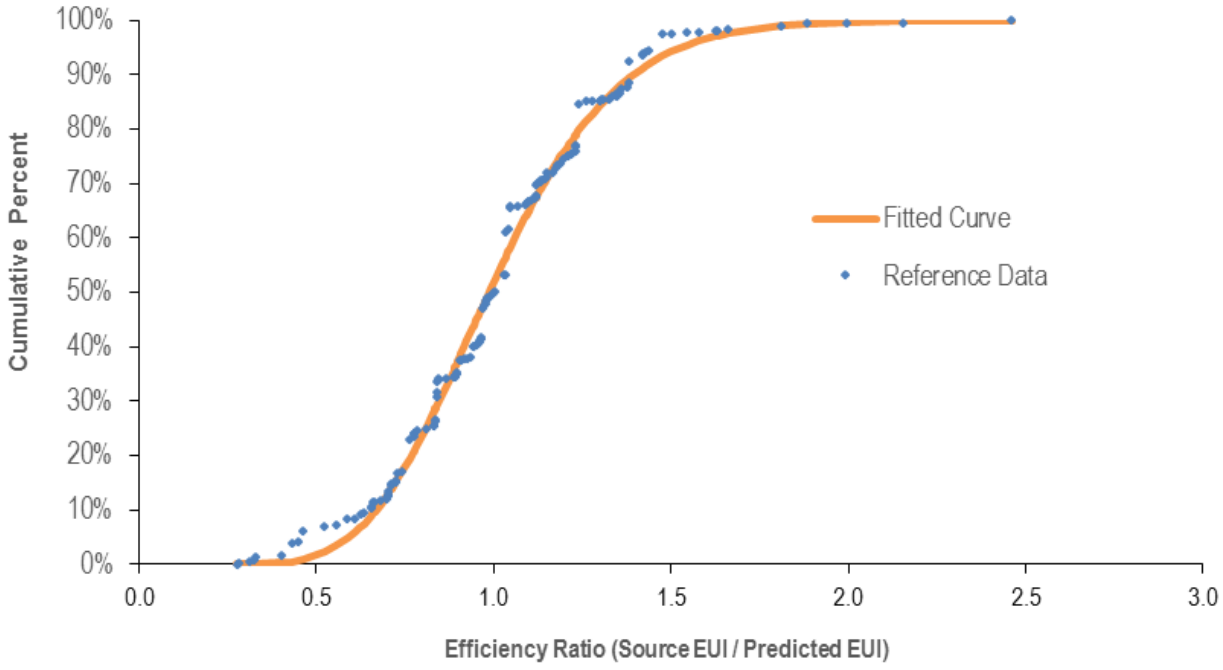
The final regression equation (presented in ***Figure 3***) yields a prediction of source EUI based on a building's operating characteristics. Some buildings in the SCIEU data sample use more energy than predicted by the regression equation, while others use less. The *actual* source EUI of each reference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

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

An efficiency ratio lower than one (1) 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 12.53 and a scale parameter (beta) of 0.08088. For this fit, the sum of the squared error is 0.093704.

Figure 4 – Distribution for Senior Care Communities and Residential Care Facilities



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% corresponds 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 Senior Care Communities and Residential Care Facilities

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	0.4677	50	50%	0.9866	0.9937
99	1%	0.4677	0.5152	49	51%	0.9937	1.0008
98	2%	0.5152	0.5471	48	52%	1.0008	1.0080
97	3%	0.5471	0.5719	47	53%	1.0080	1.0152
96	4%	0.5719	0.5927	46	54%	1.0152	1.0224
95	5%	0.5927	0.6109	45	55%	1.0224	1.0298
94	6%	0.6109	0.6271	44	56%	1.0298	1.0371
93	7%	0.6271	0.6418	43	57%	1.0371	1.0446
92	8%	0.6418	0.6554	42	58%	1.0446	1.0521
91	9%	0.6554	0.6682	41	59%	1.0521	1.0597
90	10%	0.6682	0.6801	40	60%	1.0597	1.0674
89	11%	0.6801	0.6915	39	61%	1.0674	1.0752
88	12%	0.6915	0.7023	38	62%	1.0752	1.0831
87	13%	0.7023	0.7127	37	63%	1.0831	1.0911
86	14%	0.7127	0.7226	36	64%	1.0911	1.0992
85	15%	0.7226	0.7323	35	65%	1.0992	1.1075
84	16%	0.7323	0.7416	34	66%	1.1075	1.1158
83	17%	0.7416	0.7506	33	67%	1.1158	1.1244
82	18%	0.7506	0.7595	32	68%	1.1244	1.1330
81	19%	0.7595	0.7681	31	69%	1.1330	1.1419
80	20%	0.7681	0.7765	30	70%	1.1419	1.1509
79	21%	0.7765	0.7847	29	71%	1.1509	1.1601
78	22%	0.7847	0.7928	28	72%	1.1601	1.1696
77	23%	0.7928	0.8007	27	73%	1.1696	1.1792
76	24%	0.8007	0.8085	26	74%	1.1792	1.1891
75	25%	0.8085	0.8162	25	75%	1.1891	1.1993
74	26%	0.8162	0.8238	24	76%	1.1993	1.2098
73	27%	0.8238	0.8313	23	77%	1.2098	1.2206
72	28%	0.8313	0.8388	22	78%	1.2206	1.2317
71	29%	0.8388	0.8461	21	79%	1.2317	1.2432
70	30%	0.8461	0.8534	20	80%	1.2432	1.2552
69	31%	0.8534	0.8606	19	81%	1.2552	1.2676
68	32%	0.8606	0.8678	18	82%	1.2676	1.2805
67	33%	0.8678	0.8749	17	83%	1.2805	1.2941
66	34%	0.8749	0.8820	16	84%	1.2941	1.3083
65	35%	0.8820	0.8890	15	85%	1.3083	1.3232
64	36%	0.8890	0.8960	14	86%	1.3232	1.3391
63	37%	0.8960	0.9030	13	87%	1.3391	1.3559
62	38%	0.9030	0.9100	12	88%	1.3559	1.3739
61	39%	0.9100	0.9169	11	89%	1.3739	1.3933
60	40%	0.9169	0.9239	10	90%	1.3933	1.4143
59	41%	0.9239	0.9308	9	91%	1.4143	1.4374
58	42%	0.9308	0.9377	8	92%	1.4374	1.4631
57	43%	0.9377	0.9447	7	93%	1.4631	1.4921
56	44%	0.9447	0.9516	6	94%	1.4921	1.5257
55	45%	0.9516	0.9586	5	95%	1.5257	1.5657
54	46%	0.9586	0.9655	4	96%	1.5657	1.6158
53	47%	0.9655	0.9725	3	97%	1.6158	1.6841
52	48%	0.9725	0.9795	2	98%	1.6841	1,7953
51	49%	0.9795	0.9866	1	99%	1.7953	> 1.7953

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 Senior Care Communities and Residential Care Facilities.

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	900,000 kWh
Natural gas	85,000 m^3

Property Use Details	Value
Gross floor area (m^2)	5,000
HDD (provided by Portfolio Manager, based on postal code)	4,000
CDD (provided by Portfolio Manager, based on postal code)	250
Percent of the building that is cooled	75%
Workers on the main shift	40
Licensed bed capacity	100

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	900,000 kWh	0.0036	3,240	1.96	6,350
Natural gas	85,000 m^3	0.03843	3,267	1.01	3,300
				Total Source Energy (GJ)	**9,650**
				Source EUI (GJ/m^2)	**1.930**

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 density as necessary).
- The centering values are subtracted to compute the centred variable for each operating parameter.
- The centred 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 Centred Variable	Coefficient	Coefficient x Centred Variable
Constant	-	-	-	2.01224	2.012
C_Heating degree days	4000	4,659	-659	0.00018547	-0.122
C_Cooling degree days x percent cooled	187.5	76.35	111.15	0.00208	0.231
C_Number of workers per 100 m²	0.80	0.7147	0.0853	0.32689	0.028
C_Number of beds per 100 m²	2.00	1.703	0.297	0.14543	0.043
				Predicted Source EUI (GJ/m²)	2.192

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 = 1.930 / 2.192 = 0.8805

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 0.8805 is less than 0.8820 but greater than 0.8749.
- ***The ENERGY STAR score is 66.***