ENERGY STAR® Portfolio Manager®

Technical Reference

ENERGY STAR Score for Bank Branches in Canada

OVERVIEW

The ENERGY STAR Score for Bank Branches in Canada applies to commercial banking outlets that offer banking services to walk-in customers. The objective of the ENERGY STAR score is to fairly assess how a property's energy use measures up against similar properties considering the climate, weather, and business activities. A statistical analysis of the peer building population is performed to identify the aspects of property activity that are significant drivers of energy use and to normalize for those same factors. The result of this analysis is an equation that predicts the energy use of a property, based on its business activities. This prediction is compared to the property's actual energy use to yield a 1 – 100 percentile ranking in relation to the national population of properties.

- **Property types.** The ENERGY STAR score for Bank Branches in Canada applies to commercial banking outlets that offer banking services to walk-in customers. The ENERGY STAR score applies to individual buildings only and is not available for campuses.

- **Reference data.** The analysis for bank branches 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 2019.

- **Adjustments for weather and business activity.** The analysis includes adjustments for:
  - Worker Density
  - Weather and Climate (using Heating and Cooling Degree Days, retrieved based on postal code)
  - Percent of the Building that is Cooled and Heated

- **Release date.** August 2023 is the original release date of the ENERGY STAR score for Bank Branches in Canada.

This document details the calculation of the 1 – 100 ENERGY STAR score for Bank Branches. For more information on the methodology used to set up ENERGY STAR scores, go to the Technical Reference for the ENERGY STAR Score at http://www.energystar.gov/ENERGYSTARScore.

The following sections explain how the ENERGY STAR score for Bank Branches is developed:

September 2023

Canada

REFERENCE DATA & FILTERS

The reference data used to form the peer property population relies on the Survey on Commercial and Institutional Energy Use (SCIEU), which was commissioned by Natural Resources Canada and conducted by Statistics Canada. The energy data for the survey was from the calendar year 2019. The raw data file for this survey is not publicly available, but a report providing summary results will be available on Natural Resources Canada's website at https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/databases.cfm?attr=0.

Four types of filters are applied to analyse the building energy and operating characteristics in the survey. They are set to define the peer group for comparison and to overcome any technical limitations. Those filters are: Building Type Filters, Program Filters, Data Limitation Filters, and Analytical Filters.

A complete description of each category is given in the Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARScore. ***Figure 1*** summarizes each filter used to develop the ENERGY STAR score for Bank Branch model and the rationale that supports the filter. After all filters are applied, the remaining data set has 138 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 Bank Branches

Condition for Including an Observation in the Analysis	Rationale
Defined as Bank Branch in SCIEU2019	The SCIEU survey covered the commercial and institutional sector and included buildings of all types. For this model, only the observations identified as primarily Bank Branch are used.
Must be more than 50% Bank Branch and less than 50% of any other building type	Building Type Filter – To be considered as a Bank Branch, the building must have a minimum amount of Bank Branch space.
Must have electricity consumption data	Program Filter –bank branches that do not use electricity are rare or non-existent and may indicate an omission in energy data. Electricity can be grid-purchased or produced on site.
Must be built in 2018 or earlier	Data Limitation Filter – The survey reported the energy consumption data for calendar year 2019. Therefore, if the building was being built in 2019, a full year of energy data would not be available.
Must not include energy supplied to other buildings	Data Limitation Filter – The survey asked whether the energy reported at the facility included energy supplied to other buildings such as a multi-building complex or portables. Usage data may not have been included; therefore, buildings were removed.
The area of the indoor or partially enclosed parking structures must be less than 50% of the gross floor area including indoor and partially enclosed parking structures	Program Filter – If the combined area of parking structures is more than 50% the area of the Bank Branch building, the overall structure is classified as a parking structure, not as a bank branch.
The size of the vacant space must be less than 50% of the gross floor area	Program Filter – Occupancy needs to be greater than 50% for Bank Branch to meet ENERGY STAR certification requirements.
More than 50% of the building must be heated	Program Filter – More than 50% of a bank branch must be heated for it to be considered a Bank Branch.
Must operate for at least 10 months	Program Filter – Must operate for at least 10 months for Bank Branch to meet ENERGY STAR certification requirements.

Condition for Including an Observation in the Analysis	Rationale
Must be at least 92.9 m^2	Program Filter – To be considered as a bank branch, buildings must be at least 92.9 m2 (1,000 sq. ft.) in Canada.
Must operate for at least 30 hours and less than 168 hours per week	Program Filter – To be considered as a bank branch, buildings must operate for at least one hour and less than 168 hours per week.
Must have at least one worker	Program Filter – To be considered as a bank branch, buildings must have at least one worker.
Must have at least one computer	Program Filter – To be considered as a bank branch, buildings must have at least one computer.
Must have worker density less than or equal to 5 workers 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.
Source EUI must be higher than 0.15 and lower or equal to 4.0 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.

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 intended 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. A full description of the criteria you must meet to obtain a score in Portfolio Manager is available at https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/benchmarking-frequently-asked-questions/3787#es17.

Related to the filters and eligibility criteria described above, another consideration is how Portfolio Manager treats properties 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 campus of buildings. The applicability of the ENERGY STAR score depends on the type of property. For bank branches, the score is based on individual buildings, because the primary function of the bank branches is contained within a single building and because the properties included in the reference data are single buildings. In cases where multiple bank branches are situated together (e.g., a bank branch campus), each individual building can receive its own ENERGY STAR score, but the campus cannot earn a score.

VARIABLES ANALYSED

To normalize for differences in business activity, NRCan performed 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, was analysed using a weighted ordinary least squares regression, which evaluated energy use relative to business activity (e.g. number of workers, operating hours per week, floor area, and climate).This linear regression gave an equation 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 Bank Branches in Canada.

Dependent Variables

The dependent variable is what NRCan tries to predict with the regression equation. For the Bank Branch analysis, the dependent variable is energy use, 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 Bank Branches. The units for source EUI in the Canadian model are annual gigajoules per square metre (GJ/m^2).

Independent Variables

The reference survey contains numerous property operation questions that NRCan identified as likely to be important for Bank Branches. Based on a review of the variables found in the reference data, following the criteria for inclusion in Portfolio Manager,[1] NRCan initially analysed the variables below in the regression analysis:

- Gross floor area (m²)
- Cooling degree days (CDD)
- Heating degree days (HDD)
- Percentage of floor space that is cooled
- Percentage of floor space that is heated
- Weekly hours of operation
- Number of workers during the main shift
- Number of computers
- Months in operation in 2019
- Number of domestic appliances
- Number of commercial appliances
- Number of electronic displays
- Year of construction

NRCan, with the advice of the Environmental Protection Agency (EPA) and its contractor, performed an extensive review on all of these operational characteristics individually and 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 can be evaluated in a density format: workers per 100 m^2. Overall, the analysis consists of multiple regression formulations, structured to find the

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

combination of statistically significant operating characteristics that explained the greatest amount of variance in the dependent variable: source EUI.
The final regression equation includes the following variables:

- Number of Workers on Main Shift per 100 m^2 (Worker Density)
- Percent Cooled x Cooling Degree Days (Percent Cooled x CDD)
- Percent Heated x Heating Degree Days (Percent Heated x HDD)

These variables are used together to compute the predicted source EUI for Bank Branches. The predicted source EUI is the mean EUI for a hypothetical population of buildings that share the same values for each of these characteristics. It is the mean energy for buildings that operate like your building.

Testing

NRCan further analysed the regression equation using actual data entered in Portfolio Manager. In addition to the SCIEU data, this analysis provided another set of buildings to examine the ENERGY STAR scores and distributions to assess the impacts and adjustments. It also confirmed that there are minimal biases when it comes to fundamental operational characteristics, such as percent cooled or percent heated, and 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 relies on the nationally representative reference data from SCIEU 2019, and not on data previously stored in Portfolio Manager.

REGRESSION EQUATION RESULTS

The final regression is a weighted ordinary least squares regression across the filtered data set of 380 observations. The dependent variable is source EUI. Each independent variable is centred 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 considered significant at a 90% confidence level or better, as shown by their respective significance levels.

The regression equation has a coefficient of determination (R^2) value of 0.2267, indicating that this equation explains 22.67% of the variance in source EUI for Bank Branches. 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. Recomputing the R^2 value in units of source energy[2] demonstrates that the equation explains 95.88% of the variation in total source energy of Bank Branches. It is an excellent result for a statistically based energy model.

For detailed information on the ordinary least squares regression approach, see the 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 [Weight*(Actual Source $Energy_i$ – Predicted Source $Energy_i$)]^2 across all observations. The total variation of Y is the sum of [Weight*(Actual Source $Energy_i$ – Weighted Mean Source Energy)]^2 across all observations.

Figure 2 – Descriptive Statistics for Variables in Final Regression Equation

Variable	Minimum	Median	Maximum	Mean
Source energy per square metre (GJ/m2)	0.1938	1.482	3.216	1.482
Number of Workers per 100 m^2	0.2319	2.445	4.784	2.445
Percent Cooled x CDD	0.000	221.0	389.0	221.0
Percent Heated x HDD	2677	3964	6916	3964

Figure 3 – Final Regression Results

Summary				
Dependent variable			Source energy use intensity (GJ/m2)	
Number of observations in analysis			138	
R^2 value			0.2267	
Adjusted R^2 value			0.2094	
F statistic			13.1	
Significance (p-level)			<0.0001	
	Unstandardized Coefficients	**Standard Error**	**T Value**	**Significance**
Constant	1.509	4.365E-02	34.56	<.0001
Number of Workers per 100 m^2	0.1874	5.554E-02	3.37	0.001
Percent Cooled x CDD	2.052E-03	5.889E-05	4.07	<.0001
Percent Heated x HDD	2.395E-04	4.487E-04	4.57	<.0001

Notes:
- *The regression is a weighted ordinary least squares regression, weighted by the SCIEU variable "FSWGT."*
- *All model variables are centred. The centred variable is equal to the difference between the actual value and the observed mean. The observed mean values are presented in Figure 2.*
- *HDDs and CDDs are sourced from Canadian weather stations included in the U.S. National Climatic Data Center system.*

ENERGY STAR SCORE LOOKUP TABLE

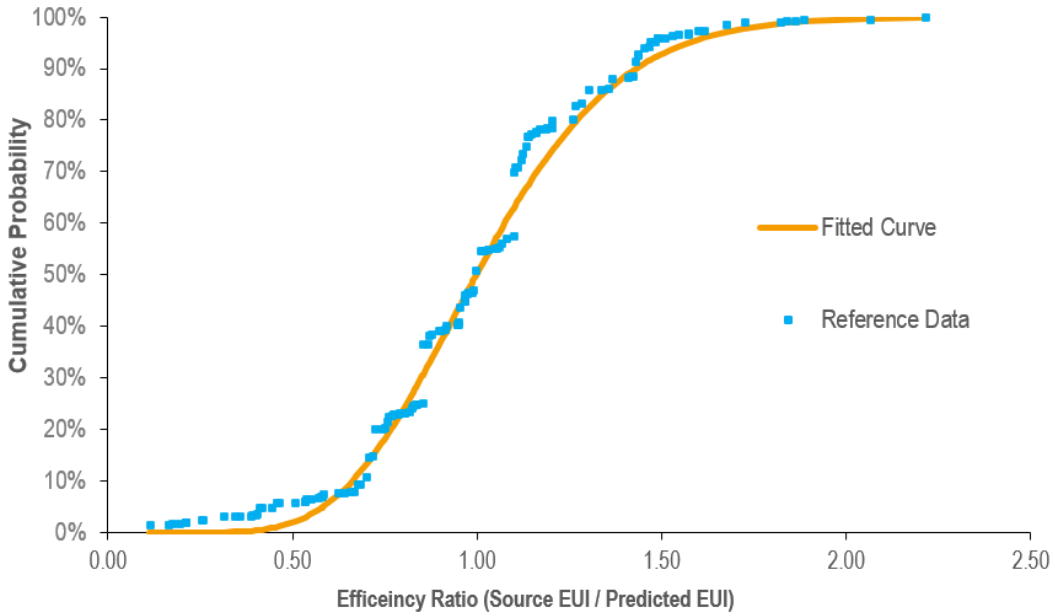
The final regression equation (presented in ***Figure 3***) gives a prediction of source EUI based on a building's operating characteristics. Some buildings in the SCIEU data sample use more energy than predicted by the regression equation, while others use less. The *actual* source EUI of each reference 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 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 to minimize the sum of squared differences between each building's actual percent rank in the group and each building's percent rank with the gamma solution. The final fit for the gamma curve gave a shape parameter (alpha) of 11.45 and a scale parameter (beta) of 0.08973. The sum of the squared error for this fit is 0.1817.

Figure 4 – Distribution for Bank Branches



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. Figure 5 shows the complete score lookup table.

Figure 5 – ENERGY STAR Score Lookup Table for Bank Branches

ENERG STAR Score	Cumulative Percentage	Energy Efficiency Ratio > =	Energy Efficiency Ratio <	ENERGY STAR Score	Cumulative Percentage	Energy Efficiency Ratio >=	Energy Efficiency Ratio <
100	0%	0.0000	0.4542	50	50%	0.9973	1.0048
99	1%	0.4542	0.5033	49	51%	1.0048	1.0123
98	2%	0.5033	0.5362	48	52%	1.0123	1.0199
97	3%	0.5362	0.5620	47	53%	1.0199	1.0275
96	4%	0.5620	0.5836	46	54%	1.0275	1.0352
95	5%	0.5836	0.6025	45	55%	1.0352	1.0430
94	6%	0.6025	0.6193	44	56%	1.0430	1.0508
93	7%	0.6193	0.6347	43	57%	1.0508	1.0587
92	8%	0.6347	0.6489	42	58%	1.0587	1.0667
91	9%	0.6489	0.6622	41	59%	1.0667	1.0748
90	10%	0.6622	0.6747	40	60%	1.0748	1.0830
89	11%	0.6747	0.6866	39	61%	1.0830	1.0912
88	12%	0.6866	0.6979	38	62%	1.0912	1.0996
87	13%	0.6979	0.7088	37	63%	1.0996	1.1081
86	14%	0.7088	0.7192	36	64%	1.1081	1.1167
85	15%	0.7192	0.7293	35	65%	1.1167	1.1255
84	16%	0.7293	0.7391	34	66%	1.1255	1.1344
83	17%	0.7391	0.7485	33	67%	1.1344	1.1434
82	18%	0.7485	0.7578	32	68%	1.1434	1.1527
81	19%	0.7578	0.7668	31	69%	1.1527	1.1621
80	20%	0.7668	0.7756	30	70%	1.1621	1.1717
79	21%	0.7756	0.7843	29	71%	1.1717	1.1815
78	22%	0.7843	0.7928	28	72%	1.1815	1.1915
77	23%	0.7928	0.8011	27	73%	1.1915	1.2018
76	24%	0.8011	0.8094	26	74%	1.2018	1.2123
75	25%	0.8094	0.8175	25	75%	1.2123	1.2232
74	26%	0.8175	0.8254	24	76%	1.2232	1.2343
73	27%	0.8254	0.8333	23	77%	1.2343	1.2458
72	28%	0.8333	0.8412	22	78%	1.2458	1.2577
71	29%	0.8412	0.8489	21	79%	1.2577	1.2700
70	30%	0.8489	0.8566	20	80%	1.2700	1.2827
69	31%	0.8566	0.8642	19	81%	1.2827	1.2960
68	32%	0.8642	0.8717	18	82%	1.2960	1.3098
67	33%	0.8717	0.8792	17	83%	1.3098	1.3242
66	34%	0.8792	0.8867	16	84%	1.3242	1.3394
65	35%	0.8867	0.8941	15	85%	1.3394	1.3554
64	36%	0.8941	0.9015	14	86%	1.3554	1.3723
63	37%	0.9015	0.9089	13	87%	1.3723	1.3902
62	38%	0.9089	0.9162	12	88%	1.3902	1.4095
61	39%	0.9162	0.9236	11	89%	1.4095	1.4302
60	40%	0.9236	0.9309	10	90%	1.4302	1.4527
59	41%	0.9309	0.9382	9	91%	1.4527	1.4774
58	42%	0.9382	0.9456	8	92%	1.4774	1.5049
57	43%	0.9456	0.9529	7	93%	1.5049	1.5360
56	44%	0.9529	0.9602	6	94%	1.5360	1.5719
55	45%	0.9602	0.9676	5	95%	1.5719	1.6149
54	46%	0.9676	0.9750	4	96%	1.6149	1.6687
53	47%	0.9750	0.9824	3	97%	1.6687	1.7420
52	48%	0.9824	0.9898	2	98%	1.7420	1.8616
51	49%	0.9898	0.9973	1	99%	1.8616	>1.8616

EXAMPLE CALCULATION

According to the Technical Reference for the ENERGY STAR Score at www.energystar.gov/ENERGYSTARScore, there are five steps to compute a score for Bank Branches. Below is a specific example:

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	168,000 kWh
Natural gas	9,600 m^3

Property Use Details	Value
Gross floor area (m^2)	1300
Number of Full-time Workers on Main Shift	24
Percent Cooled	100%
Percent Heated	100%
CDD (provided by Portfolio Manager, based on postal code)	113
HDD (provided by Portfolio Manager, based on postal code)	4,766

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	168,000 kWh	3.600E-03	604.8	1.830	1107
Natural gas	9,600 m^3	3.843E-02	368.9	1.060	391.1
				Total Source Energy (GJ)	1498
				Source EUI (GJ/m^2)	**1.152**

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 centring values are subtracted to compute the centred variable for each operating parameter (e.g., actual building value minus reference centring value).
- The centred variables are multiplied by the coefficients from the Bank Branches regression equation to obtain a predicted source EUI.

Computing Predicted Source EUI

Variable	Actual Building Value	Reference Centring Value	Building Centred Variable	Coefficient	Coefficient x Centred Variable
Constant	-	-	-	1.509	1.509
Worker Density	2	2.523	-0.6770	0.1874	-0.1268
Percent Cooled x CDD	113	186.1	-73.10	2.052E-03	-0.1500
Percent Heated x HDD	4766	3982	784.0	2.395 E-04	0.1878
			Predicted Source EUI (GJ/m²)		**1.420**

4 Portfolio Manager computes the energy efficiency ratio

- The ratio equals the actual source EUI (Step 2) divided by the predicted source EUI (Step 3).
- Ratio = 1.420 / 1.152 = 0.8114

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 0.8114 is greater than 0.8094 and less than 0.8175.
- ***The ENERGY STAR score is 75.***