

ENERGY STAR Score for Mailing Centers / Post Offices in Canada

OVERVIEW

The ENERGY STAR score for Mailing Centers/Post Offices applies to post offices, as well as private establishments that offer mailing services and supplies. 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 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 to 100 percentile ranking in relation to the national population of properties.

- **Property types.** The ENERGY STAR score for Mailing Centers/Post Offices in Canada applies to post offices and other mail buildings. The score applies to individual buildings and not entire campuses of mail establishments.
- **Reference data.** The analysis for Mailing Centers/Post Offices in Canada is based on data provided by Canada Post Corporation representing the energy year 2021.
- **Adjustments for weather and business activity.** The analysis includes adjustments for:
 - Building size
 - Number of workers on the main shift
 - Hours of operation per week
 - Number of letters and packages per year
 - Percent of the building that is heated and cooled
 - Weather and Climate (using heating degree days and cooling degree days, retrieved based on postal code)
- **Release date.** August 2023 is the original release date of the ENERGY STAR score for Mailing Centers/Post Offices in Canada.

This document details the development of the 1 – 100 ENERGY STAR score for Mailing Centers/Post Offices properties. For more information on the methodology used to develop 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 Mailing Centers/Post Offices is developed:

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REFERENCE DATA & FILTERS

The reference data used to form the peer property population relies on data provided by Canada Post Corporation (CPC), representing mail depots owned and operated by the CPC. The energy data for the survey was from the calendar year 2021. The raw collected data file for this survey is not publicly available.

Four types of filters are applied to analyze the building energy and operating characteristics in the survey. They are set to define the peer population 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 Mailing Centers/Post Offices model and the rationale that supports the filter. After all filters are applied, the remaining data set has 222 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 Mailing Centers/Post Offices

Condition for Including an Observation in the Analysis	Rationale
Identified as a 'Depot' by Canada Post	Building Type Filter – In order to be considered a Mailing Center/Post Office, buildings must meet the definition of Depot.
Building must not be a mechanized sortation facility (Plant)	Building Type Filter - Mechanized facilities are distinct from other depots due to significant amounts of automation.
Building must have 52 weeks of mail volume information	Program Filter – Basic requirement to be considered as full-time operation.
Building must be 'In service' for the 2021 calendar year	Program Filter – Basic requirement to be considered as full-time operation.
The building must have at least one worker	Program Filter – Requirement to be considered a Mailing Center/Post Office.
The building must have a Source EUI greater than or equal to 0.5 GJ/m ²	Analytical Filter – Values determined to be statistical outliers.
The building must have a worker density greater than or equal to 0.1 workers per 100m ²	Analytical Filter – Values determined to be statistical outliers.
The building must have an annual density of mail products less than or equal to 900,000 products per 100m ²	Analytical Filter – Values determined to be statistical outliers.

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. In some cases, a subset of the data has a different behaviour from the rest of the properties (e.g., Mailing Centers/Post Offices with more than 900,000 mail products per 100m² behave differently than less busy locations), 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 obtain a score in Portfolio Manager is available at <https://natural-resources.canada.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 Mailing Centers/Post Offices, the score is based on individual establishments and is not available for a campus of buildings.

VARIABLES ANALYZED

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 analyzed 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 gives 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 Mailing Centers/Post Offices in Canada.

Dependent Variables

The dependent variable is what NRCan tries to predict with the regression equation. For the Mailing Centers/Post Offices 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 Mailing Centers/Post Offices. The units for source EUI in the Canadian model are annual gigajoules per square metre (GJ/m²).

Independent Variables

The reference survey contains numerous property operation questions that NRCan identified as likely to be important for Mailing Centers/Post Offices. Based on a review of the variables found in the reference data, and following the criteria for inclusion in Portfolio Manager,¹ NRCan initially analyzed the following variables in the regression analysis:

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

- 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
- Mix of mail product types (e.g., percent of mail that is letter mail, parcels, packages etc.)
- Number of letters and packages per year
- Delivery method (e.g., foot delivery, van delivery etc.)
- Number of delivery routes

NRCan, with the advice of the Environmental Protection Agency (EPA) and their contractor, performed an extensive review on all 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 letters and packages per year can be evaluated in a density format: annual quantity of mail products per 100m². The mail density (as opposed to the gross sum of mail) is more closely related to the energy use intensity. In addition, using analytical results and residual plots, variables were assessed using different transformations (such as the natural logarithm, abbreviated as Ln). Overall, the analysis consists of multiple regression formulations, structured to find the 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:

- Gross floor area, capped at 2500m² (GFA Cap)
- Weekly operating hours (Hours)
- Annual quantity of mail products per 100m² (Mail Density)
- The percentage of the building that is cooled times the number of Cooling Degree Days (Percent Cooled x CDD)
- The percentage of the building that is heated times the number of Heating Degree Days (Percent Heated x HDD)
- Number of workers per 100m² (Worker Density)

These variables are used together to compute the predicted source EUI for Mailing Centers/Post Offices. 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.

Mail Density

Mail density is an important term used to capture the intensity of activity within the building. Annual mail volumes were chosen to account for seasonal differences such as mail volume around holidays. The different types of mail (such as letter, packet, package, etc.) were analysed to ensure that certain mail types did not contribute to more or less energy consumption.

Gross Floor Area

In the dataset, there existed a strong trend towards larger buildings using less energy per meter square when considering climate and business activity. The effect was present in buildings up to 2500 m², after which increasing size did not have an impact on energy intensity. Therefore, the final regression equation includes a gross floor area term, which is capped at a maximum value of 2500 m². This means that buildings over 2500 m² will receive the same adjustment as those with an area of 2500 m².

Cooling Degree Days

Due to the limited variance of CDD within a single sample year, and the complex relationship between HDD and CDD in different climate regions in Canada, NRCan had concerns that the impact of cooling was not being fully represented in the model. To adjust, NRCan used a combination of analysis techniques, including linear regression of EUI and Percent Cooled x CDD in the survey data, review of engineering models, and comparisons to Portfolio Manager data, to determine an appropriate factor to account for cooling energy. From the analysis, the rate of increase of source energy to Percent Cooled x CDD was determined. Applying this adjustment resulted in a more comprehensive model with both cooling and heating terms that is better adapted to changing climate trends.

Testing

NRCan further analyzed the regression equation using actual data entered in Portfolio Manager. In addition to the regression dataset, 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, 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 is based on the nationally representative reference data from CPC, not on other user data previously entered into Portfolio Manager. While the reference data is from public post office data, the corresponding score is also applicable to private buildings with mail delivery.

REGRESSION EQUATION RESULTS

The final regression is a weighted ordinary least squares regression across the filtered data set of 222 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 0.3196, indicating that this equation explains 31.96% 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. Recomputing the R^2 value in units of source energy² demonstrates that the equation actually explains 80.4% of the variation in total source energy of Mailing Centers/Post Offices. It is a good result for a statistically based energy model.

For detailed information on the ordinary least squares regression approach, go to the Technical Reference for the ENERGY STAR Score, at www.energystar.gov/ENERGYSTARscore.

Figure 2 – Descriptive Statistics for Variables in Final Regression Equation

Variable	Minimum	Median	Maximum	Mean
Source energy per square metre (GJ/m ²)	0.5762	1.464	3.074	1.482
GFA Cap*	265.5	1417	2,500	1518
Hours	35.00	77.50	148.0	81.46
Mail Density	41,754	261,705	863,010	324,589
Percent Cooled x CDD	15.00	252.0	638.0	262.7
Percent Heated x HDD	2751	3912	7312	4058
Worker Density	0.2923	1.914	11.06	2.307

*GFA Cap is capped at 2500

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

Figure 3 – Final Regression Results

Summary				
Dependent variable	Source energy use intensity (GJ/m ²)			
Number of observations in analysis	222			
R ² value	0.3196			
Adjusted R ² value	0.3039			
F statistic	20.30			
Significance (p-level)	< 0.0001			
	Unstandardized Coefficients	Standard Error	T Value	Significance (p-level)
Constant	1.482	2.471E-02	60.00	<.0001
GFA Cap*	-1.977E-04	4.266E-05	-4.634	<.0001
Hours	3.109E-03	9.456E-04	3.287	0.0012
Mail Density	2.479E-07	1.419E-07	1.748	0.0819
Percent Cooled x CDD	2.000E-04	n/a	n/a	n/a
Percent Heated x HDD	2.455E-04	3.183E-05	7.713	<.0001
Worker Density	4.491E-02	1.710E-02	2.627	0.0092

- Notes:
- *GFA Cap is capped at 2500
- The regression is an ordinary least squares regression.
- All model variables are 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.
- 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

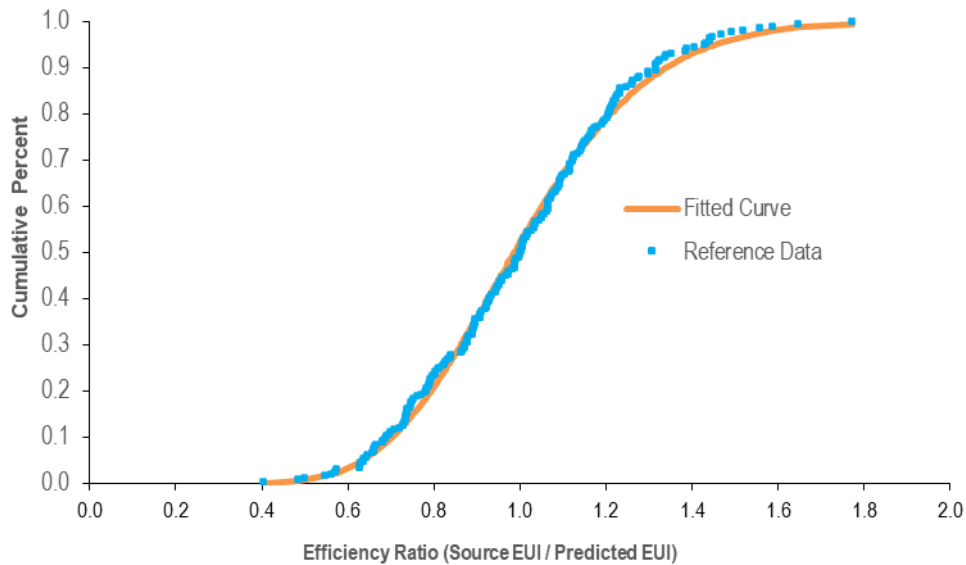
The final regression equation (presented in **Figure 3**) gives a prediction of source EUI based on a building’s operating characteristics. Some buildings in the SCIEU data sample use more energy than predicted by the regression equation, while others use less. The *actual* source EUI of each reference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

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

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 population and each building’s percent rank with the gamma solution. The final fit for the gamma curve gives a shape parameter (alpha) of 16.10 and a scale parameter (beta) of 0.06259. The sum of the squared error for this fit is 0.03073.

Figure 4 – Distribution for Mailing Centers/Post Offices



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 registers such a small or even smaller ratio. 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 registers such a small or even smaller ratio. **Figure 5** shows the complete score lookup table.

Figure 5 – ENERGY STAR Score Lookup Table for Mailing Centers/Post Offices

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	0.5163	50	50%	0.9866	0.9929
99	1%	0.5163	0.5610	49	51%	0.9929	0.9991
98	2%	0.5610	0.5907	48	52%	0.9991	1.0054
97	3%	0.5907	0.6137	47	53%	1.0054	1.0118
96	4%	0.6137	0.6329	46	54%	1.0118	1.0181
95	5%	0.6329	0.6496	45	55%	1.0181	1.0246
94	6%	0.6496	0.6644	44	56%	1.0246	1.0310
93	7%	0.6644	0.6779	43	57%	1.0310	1.0376
92	8%	0.6779	0.6904	42	58%	1.0376	1.0442
91	9%	0.6904	0.7020	41	59%	1.0442	1.0508
90	10%	0.7020	0.7129	40	60%	1.0508	1.0576
89	11%	0.7129	0.7232	39	61%	1.0576	1.0644
88	12%	0.7232	0.7330	38	62%	1.0644	1.0713
87	13%	0.7330	0.7424	37	63%	1.0713	1.0783
86	14%	0.7424	0.7514	36	64%	1.0783	1.0853
85	15%	0.7514	0.7601	35	65%	1.0853	1.0925
84	16%	0.7601	0.7685	34	66%	1.0925	1.0998
83	17%	0.7685	0.7767	33	67%	1.0998	1.1073
82	18%	0.7767	0.7846	32	68%	1.1073	1.1148
81	19%	0.7846	0.7923	31	69%	1.1148	1.1225
80	20%	0.7923	0.7999	30	70%	1.1225	1.1304
79	21%	0.7999	0.8073	29	71%	1.1304	1.1384
78	22%	0.8073	0.8145	28	72%	1.1384	1.1466
77	23%	0.8145	0.8217	27	73%	1.1466	1.1550
76	24%	0.8217	0.8287	26	74%	1.1550	1.1636
75	25%	0.8287	0.8355	25	75%	1.1636	1.1724
74	26%	0.8355	0.8423	24	76%	1.1724	1.1815
73	27%	0.8423	0.8490	23	77%	1.1815	1.1908
72	28%	0.8490	0.8557	22	78%	1.1908	1.2004
71	29%	0.8557	0.8622	21	79%	1.2004	1.2104
70	30%	0.8622	0.8687	20	80%	1.2104	1.2207
69	31%	0.8687	0.8751	19	81%	1.2207	1.2315
68	32%	0.8751	0.8815	18	82%	1.2315	1.2427
67	33%	0.8815	0.8878	17	83%	1.2427	1.2543
66	34%	0.8878	0.8941	16	84%	1.2543	1.2666
65	35%	0.8941	0.9004	15	85%	1.2666	1.2795
64	36%	0.9004	0.9066	14	86%	1.2795	1.2931
63	37%	0.9066	0.9128	13	87%	1.2931	1.3075
62	38%	0.9128	0.9190	12	88%	1.3075	1.3230
61	39%	0.9190	0.9251	11	89%	1.3230	1.3396
60	40%	0.9251	0.9313	10	90%	1.3396	1.3577
59	41%	0.9313	0.9374	9	91%	1.3577	1.3775
58	42%	0.9374	0.9435	8	92%	1.3775	1.3994
57	43%	0.9435	0.9497	7	93%	1.3994	1.4242
56	44%	0.9497	0.9558	6	94%	1.4242	1.4529
55	45%	0.9558	0.9619	5	95%	1.4529	1.4870
54	46%	0.9619	0.9681	4	96%	1.4870	1.5296
53	47%	0.9681	0.9742	3	97%	1.5296	1.5875
52	48%	0.9742	0.9804	2	98%	1.5875	1.6816
51	49%	0.9804	0.9866	1	99%	1.6816	>1.6816

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 Mailing Centers/Post Offices. The following is an 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	135,000 kWh
Natural gas	12,000 m ³

Property Use Details	Value
Gross floor area (m ²)	1,000
Weekly operating hours	55
Number of Workers on Main Shift	60
Number of letters and packages per year	8,000,000
Delivery Facility	Yes
Percent That Can Be Heated	100%
Percent That Can Be Cooled	100%
HDD (provided by Portfolio Manager, based on postal code)	3,500
CDD (provided by Portfolio Manager, based on postal code)	300

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	135,000 kWh	3.600E-03	486.0	1.830	889.4
Natural gas	12,000 m ³	3.843E-02	461.2	1.060	488.9
Total Source Energy (GJ)					1,378
Source EUI (GJ/m²)					1.378

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 centered variable for each operating parameter.
- The centered variables are multiplied by the coefficients from the warehouse 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	-	-	-	1.482	1.482
GFA Cap*	1000	1518	-518.0	-1.977E-04	0.1024
Hours	55	81.46	-26.46	3.109E-03	-8.226E-02
Mail Density	800000	324589	475411	2.479E-07	0.1179
Percent Cooled x CDD	300	262.7	37.30	2.000E-04	7.460E-03
Percent Heated x HDD	3500	4058	-558.0	2.455E-04	-0.1370
Worker Density	6	2.307	3.693	4.491E-02	0.1659
				Predicted Source EUI (GJ/m²)	1.656

*GFA capped at 2500

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 = 1.378 / 1.656 = **0.8321**

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 0.8321 is greater than 0.8287 and less than 0.8355.
- **The ENERGY STAR score is 75.**