Technical Reference

ENERGY STAR Score for Medical Offices in Canada

OVERVIEW

The ENERGY STAR score for medical offices applies to all medical offices. 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 to 100 percentile ranking in relation to the national population of properties.

- **Property types.** The ENERGY STAR score for medical offices in Canada applies to medical offices used to provide diagnosis and treatment for medical, dental, or psychiatric outpatient care. The score applies to individual medical offices and is not available for a campus of buildings.
- **Reference data.** The analysis for medical offices in Canada relies 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. The SCIEU represents the energy use for the year 2014.
- **Adjustments for weather and business activity.** The analysis includes adjustments for:
    - Computer density (the number of computers per 100 m^2)
    - Percentage of the building that is cooled
    - Percentage of the building that is heated
    - Weather and climate (using cooling degree and heating degree days, retrieved based on postal code)
    - Weekly operating hours
- **Release date.** This is the second release of the *ENERGY STAR Score for Medical Offices in Canada*. The *ENERGY STAR Score for Medical Offices* is updated periodically as more recent data becomes available:
    - Most recent update: February 2020
    - Original release: August 2015

This document details the calculation of the 1 - 100 ENERGY STAR score for medical office properties. For more information on the methodology used to develop ENERGY STAR scores, see the *Portfolio Manager Technical Reference: ENERGY STAR Score* at www.energystar.gov/ENERGYSTARScore.

The following sections explain how the ENERGY STAR score for medical offices is developed.

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 (NRCan) and conducted by Statistics Canada in late 2015 and early 2016. The energy data for the survey was from the calendar year 2014. The raw collected data file for this survey is not available publicly, but a report providing summary results is available on the NRCan website at oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/scieu/2014/tables.cfm.

Four types of filters are applied to analyze 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 *Portfolio Manager Technical Reference: ENERGY STAR Score* at www.energystar.gov/ENERGYSTARScore. **Figure 1** summarizes each filter used to set the ENERGY STAR score for the medical office model and the rationale that supports the filter. After all filters are applied, the remaining data set has 136 observations. NRCan cannot identify the number of cases after each filter because the survey data are confidential.

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

Condition for Including an Observation in the Analysis	Rationale
Defined as category 2 in the SCIEU – Medical Office	The SCIEU survey covered the commercial and institutional sector and included buildings of all types. For this model, only the observations identified as primarily medical office are used.
Cannot be a senior care establishment or hospital	Building Type Filter – To be considered a medical office, the building cannot be a senior care establishment or hospital.
Must be more than 50% medical office and less than 50% of any other building type	Building Type Filter – To be considered a medical office, the building must have a minimum amount of medical office space.
Must have electricity consumption data	Program Filter – Medical offices 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 not use any “other” fuels for which the consumption is not reported	Data Limitation Filter – The survey asked if fuels other than those in the following list were consumed in the facility. The fuels are purchased electricity, electricity generated on-site from renewable sources, natural gas, light fuel oil, diesel, kerosene, propane, district steam, district hot water or district chilled water. Either the energy type was not defined or, in the case of wood, the unit of energy was not easily convertible. Therefore, the energy provided by these fuels could not be compared directly. In such cases, these observations were removed from the analysis.
Must be built in 2013 or earlier	Data Limitation Filter – The survey reported the energy consumption data for calendar year 2014. Therefore, if the building was being built in 2014, a full year of energy consumption data would not be available.
Must operate for at least 30 hours per week	Program Filter – Medical offices must operate for at least 30 hours per week to be considered a full-time operating medical office.

Condition for Including an Observation in the Analysis	Rationale
More than 50% of the building must be heated	Program Filter – More than 50% of a medical office must be heated for it to be considered a medical office.
More than 50% of the building must be cooled	Program Filter – More than 50% of a medical office must be cooled for it to be considered a medical office.
Must not include energy supplied to other buildings	Data Limitation Filter – The survey asked if the energy use 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 of the medical office building and the parking structures combined.	Program Filter – If the combined area of the parking structures is more than 50% the area of the medical office building, the overall structure is classified as a parking structure, not a medical office.
The area of the vacant space must be less than 50% of the gross floor area of the building.	Program Filter – Occupancy of the building, by area, must be greater than 50% for a medical office.
Must operate at least 10 months per year	Program Filter – Medical offices must operate for at least10 months per year to be considered a full-time operating medical office.
Must have at least one computer	Program Filter – Medical offices that do not have computers are rare or non-existent and may indicate an omission in data.
Must have at least one worker	Program Filter – Medical offices that do not have workers are rare or non-existent and may indicate an omission in data.
Must have sterilization density of less than 6 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.
Must have computer density less than 10 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.
Must have a source EUI must be less than 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.
Must be at least 92.9 m^2 (1,000 sq. ft.). in area	Analytical Filter – The analysis could not model behaviours for buildings smaller than 92.9 m^2 (1,000 sq. ft.).
Must be less than or equal to 35,000 m^2 in area	Analytical Filter – Values determined to be outliers based on analysis of the data. In Canada, most single medical offices do not exceed 35,000 m^2.

Some of the filters applied to the reference data result in constraints on calculating a score in Portfolio Manager. 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 affect eligibility. A full description of the criteria you must meet to obtain a score in Portfolio Manager is available at nrcan.gc.ca/energy/efficiency/buildings/energy-benchmarking/faq/3787#faq292.

Related to the filters and eligibility criteria described previously, 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 medical offices, the score is based on a single building.

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. This analysis 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 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 medical offices in Canada.

Dependent Variables

NRCan tries to predict the dependent variable with the regression equation. For the medical offices analysis, the dependent variable is energy use, expressed in source energy use intensity (source EUI). This source EUI 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, which are those factors that explain the variation in source energy use per square metre in medical offices. 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 medical 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:

- Gross floor area (m^2)
- 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 2014
- Number of commercial appliances
- Number of sterilization units
- Number of MRI units
- Number of beds
- Number of elevators
- Number of televisions/electronic displays/LCDs
- Year of construction

[1] For a complete explanation of these criteria, see the *Portfolio Manager Technical Reference: ENERGY STAR Score* at www.energystar.gov/ENERGYSTARScore.

NRCan, with the advice of the Environmental Protection Agency (EPA), performed an extensive review of these operational characteristics individually and in combination with each other (e.g. heating degree days times percentage of floor space that is 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: workers per 100 m^2. The worker density (as opposed to the gross number of workers) is more closely related to the EUI. In addition, using analytical results and residual plots, variables were assessed by using different transformations (such as the natural logarithm, abbreviated as Ln). 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:

- Number of computers per 100 m^2 (computer density)
- Percentage of the building that is cooled times the number of cooling degree days (percentage cooled x CDD)
- Percentage of the building that is heated times the number of heating degree days (percentage heated x HDD)
- Natural log of weekly operating hours Ln (weekly operating hours)

These variables are used together to compute the predicted source EUI for medical 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. The predicted source EUI is the mean energy for buildings that operate like your building.

Computer Density Analysis

Computer density (computers per 100 m^2) and worker density (workers per 100 m^2) both showed a positive correlation with energy usage. Both variables represent measures of occupant activity in medical offices. The high correlation between computer density and worker density allowed the inclusion of only one of the terms in the model. Computer density showed stronger statistical significance and was, therefore, included in the model.

Medical Diagnosis or Treatment Machines

The SCIEU 2014 collected data on the presence of various types of medical equipment, including x-ray and MRI machines. Because MRI machines are potentially high energy consumers, it was important to investigate their impact on energy and EUI. However, the analysis indicated that the number of medical diagnosis and treatment machines (including MRI machines) was not a statistically significant predictor of EUI in medical offices.

Testing

NRCan also analyzed the regression equation by using actual data entered in Portfolio Manager. In addition to the SCIEU data, this analysis provided another set of buildings for examination of the ENERGY STAR scores and distributions to assess the impacts and adjustments. The analysis also confirmed that there are minimal biases in fundamental operational characteristics such as percentage of the floor area cooled or percentage of the floor area heated, Analysis also showed 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 2014, 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 136 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 0.3443, indicating that this equation explains 34.43% of the variance in source EUI for medical offices. The explanatory power of the area is not included in the R^2 value because the final equation is structured with energy per unit area as the dependent variable. Consequently, this value appears artificially low. Re-computing the R^2 value in units of source energy[2] demonstrates that the equation explains 92.96% of the variation in total source energy of medical offices. It is an excellent result for a statistically based energy model.

For detailed information on the ordinary least squares regression approach, see the *Portfolio Manager Technical Reference: 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 the 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 a Final Regression Equation

Variable	Minimum	Median	Maximum	Mean
Source energy per square metre (GJ/m^2)	0.3085	1.652	3.975	1.707
Computer Density*	3.280E-02	1.676	9.936	2.382
Percent That Can Be Cooled x CDD	0.3333	143.4	409.5	163.1
Percent That Can Be Heated x HDD	1408	4966	6923	4782
Ln (Weekly Operating Hours)	3.689	3.850	5.124	3.950

Figure 3 – Final Regression Results

Summary				
Dependent variable	Source energy use intensity (GJ/m^2)			
Number of observations in the analysis	136			
R^2 value	0.3443			
Adjusted R^2 value	0.3242			
F statistic	17.19			
Significance (p-level)	< 0.0001			
	Unstandardized Coefficients	**Standard Error**	**T Value**	**Significance (p-level)**
Constant	1.707	4.820E-02	35.41	<.0001
Computer Density	0.1795	2.483E-02	7.233	<.0001
Percent That Can Be Cooled x CDD	2.967E-03	5.856E-04	5.066	<.0001
Percent That Can Be Heated x HDD	1.075E-04	6.187E-05	1.737	0.0847
Ln (Weekly Operating Hours)	0.3056	0.1722	1.775	0.0783

Notes:
- The regression is a weighted ordinary least squares regression, weighted by the SCIEU variable “SWEIGHT.”
- 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.
- 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

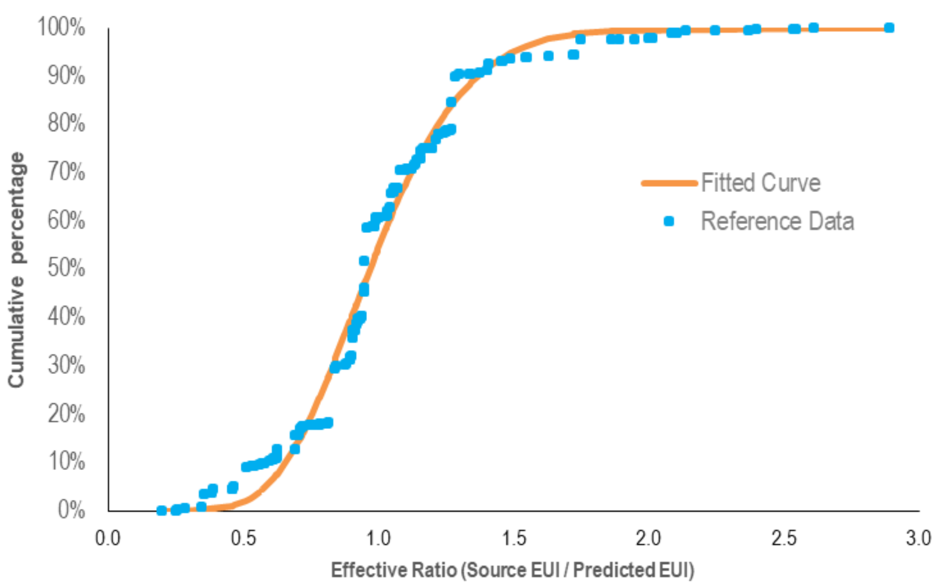
The final regression equation (presented in **Figure 3**) gives a prediction of source EUI based on a building’s operating characteristics. Some buildings in the SCIEU data sample use more energy than predicted by the regression equation, while others use less. The *actual* source EUI of each reference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

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

An energy efficiency ratio lower than 1 indicates that a building uses less energy than predicted and, consequently, is more efficient. An energy efficiency ratio above 1 indicates the opposite.

The energy efficiency ratios are sorted from smallest to largest, and the cumulative percentage of the population at each ratio is computed by 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 by using a two-parameter gamma distribution. The fit is performed to minimize the sum of squared differences between each building's actual percentage rank in the group and each building's percentage rank with the gamma solution. The final fit for the gamma curve gave a shape parameter (alpha) of 12.60 and a scale parameter (beta) of 0.07896. The sum of the squared error for this fit is 0.2286.

Figure 4 – Distribution for Medical Offices



The final gamma shape and scale parameters are used to calculate the energy 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 Medical Offices

ENERGY STAR Score	Cumulative Percentage	Energy Efficiency Ratio > =	<
100	0%	0.0000	0.4603
99	1%	0.4603	0.5070
98	2%	0.5070	0.5382
97	3%	0.5382	0.5626
96	4%	0.5626	0.5830
95	5%	0.5830	0.6007
94	6%	0.6007	0.6166
93	7%	0.6166	0.6311
92	8%	0.6311	0.6444
91	9%	0.6444	0.6569
90	10%	0.6569	0.6686
89	11%	0.6686	0.6798
88	12%	0.6798	0.6904
87	13%	0.6904	0.7005
86	14%	0.7005	0.7103
85	15%	0.7103	0.7197
84	16%	0.7197	0.7288
83	17%	0.7288	0.7377
82	18%	0.7377	0.7463
81	19%	0.7463	0.7548
80	20%	0.7548	0.7630
79	21%	0.7630	0.7711
78	22%	0.7711	0.7790
77	23%	0.7790	0.7868
76	24%	0.7868	0.7944
75	25%	0.7944	0.8020
74	26%	0.8020	0.8094
73	27%	0.8094	0.8168
72	28%	0.8168	0.8240
71	29%	0.8240	0.8312
70	30%	0.8312	0.8383
69	31%	0.8383	0.8454
68	32%	0.8454	0.8524
67	33%	0.8524	0.8594
66	34%	0.8594	0.8663
65	35%	0.8663	0.8732
64	36%	0.8732	0.8801
63	37%	0.8801	0.8869
62	38%	0.8869	0.8938
61	39%	0.8938	0.9006
60	40%	0.9006	0.9074
59	41%	0.9074	0.9141
58	42%	0.9141	0.9209
57	43%	0.9209	0.9277
56	44%	0.9277	0.9345
55	45%	0.9345	0.9413
54	46%	0.9413	0.9482
53	47%	0.9482	0.9550
52	48%	0.9550	0.9619
51	49%	0.9619	0.9688

ENERGY STAR Score	Cumulative Percentage	Energy Efficiency Ratio >=	<
50	50%	0.9688	0.9757
49	51%	0.9757	0.9827
48	52%	0.9827	0.9897
47	53%	0.9897	0.9968
46	54%	0.9968	1.0039
45	55%	1.0039	1.0111
44	56%	1.0111	1.0183
43	57%	1.0183	1.0256
42	58%	1.0256	1.0329
41	59%	1.0329	1.0404
40	60%	1.0404	1.0479
39	61%	1.0479	1.0556
38	62%	1.0556	1.0633
37	63%	1.0633	1.0711
36	64%	1.0711	1.0791
35	65%	1.0791	1.0871
34	66%	1.0871	1.0953
33	67%	1.0953	1.1037
32	68%	1.1037	1.1122
31	69%	1.1122	1.1208
30	70%	1.1208	1.1296
29	71%	1.1296	1.1387
28	72%	1.1387	1.1479
27	73%	1.1479	1.1574
26	74%	1.1574	1.1671
25	75%	1.1671	1.1770
24	76%	1.1770	1.1873
23	77%	1.1873	1.1978
22	78%	1.1978	1.2087
21	79%	1.2087	1.2200
20	80%	1.2200	1.2317
19	81%	1.2317	1.2439
18	82%	1.2439	1.2565
17	83%	1.2565	1.2698
16	84%	1.2698	1.2837
15	85%	1.2837	1.2983
14	86%	1.2983	1.3138
13	87%	1.3138	1.3303
12	88%	1.3303	1.3479
11	89%	1.3479	1.3668
10	90%	1.3668	1.3874
9	91%	1.3874	1.4100
8	92%	1.4100	1.4351
7	93%	1.4351	1.4635
6	94%	1.4635	1.4964
5	95%	1.4964	1.5355
4	96%	1.5355	1.5846
3	97%	1.5846	1.6513
2	98%	1.6513	1.7601
1	99%	1.7601	>1.7601

EXAMPLE CALCULATION

According to the *Portfolio Manager Technical Reference: ENERGY STAR Score* at www.energystar.gov/ENERGYSTARScore, there are five steps in computing a score for medical offices. The following is a specific example.

1 User enters the 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	1,200,000 kWh
Natural gas	120,000 m^3

Property Use Details	Value
Gross Floor Area (m^2)	10,000
Weekly Operating Hours	70
Number of Computers	311
Percent That Can Be Heated	100%
Percent That Can Be Cooled	100%
HDD (provided by Portfolio Manager, based on postal code)	2035
CDD (provided by Portfolio Manager, based on postal code)	165

2 Portfolio Manager computes the actual source EUI

- The 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 the Actual Source EUI

Fuel	Billing Units	Site GJ Multiplier	Site GJ	Source Multiplier	Source GJ
Electricity	1,200,000 kWh	3.600E-03	4,320	1.960	8,467
Natural gas	120,000 m^3	3.843E-02	4,612	1.010	4,658
				Total source energy (GJ)	13,125
				Source EUI (GJ/m^2)	**1.313**

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.
- The centred variables are multiplied by the coefficients from the warehouse regression equation to obtain a predicted source EUI.

Computing the Predicted Source EUI

Variable	Actual Building Value	Reference Centring Value	Building Centred Variable	Coefficient	Coefficient x Centred Variable
Constant	-	-	-	1.707	1.707
Computer Density*	3.110	2.382	0.728	0.1795	0.1307
Percent Cooled x CDD	165.0	163.1	1.929	2.967E-03	5.723E-03
Percent Heated x HDD	2035	4782	-2747	1.075E-04	-0.2953
Ln (Weekly Operating Hours)	4.2485	3.950	0.2985	0.3056	0.09122
			Predicted source EUI (GJ/m²)		**1.639**

**Computers per 100 m²*

4 Portfolio Manager computes the energy efficiency ratio

- The energy efficiency ratio equals the actual source EUI (Step 2) divided by the predicted source EUI (Step 3).
- Ratio = 1.313 / 1.639 = **0.8009**

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 0.8009 is greater than 0.7944 and less than 0.8020.
- ***The ENERGY STAR score is 75.***