ENERGY STAR® PortfolioManager® Technical Reference

Parking and the ENERGY STAR Score in the United States and Canada

OVERVIEW

The ENERGY STAR score provides a fair assessment of the energy performance of a property relative to its peers, accounting for climate, weather, and business activities at the property. Parking areas are not eligible to earn the ENERGY STAR score. However, because parking is a common amenity at other commercial building types (e.g., offices and hotels), the ENERGY STAR score does make adjustments to accommodate for the presence of parking. The goal of the ENERGY STAR score is to rate the energy performance of the primary use of the building, not the parking.

- **Technical Approach.** The engineered model described in this document provides estimated energy use for parking. Subtracting this estimated energy use from the building's actual energy use yields an estimate of energy use of the building without parking. This allows the building to be evaluated as though it does not have parking.
- **Property Types.** Parking areas can be entered for all property types and adjustments will be incorporated into the ENERGY STAR score for eligible property types. This includes open parking lots, completely enclosed or underground parking garages (with walls on all sides), and partially enclosed parking garages. If the energy consumption of parking areas is separately metered from the main facility with which it is associated, it does not need to be entered into Portfolio Manager.
- **Adjustments.** The parking adjustment model is based on engineered assumptions regarding basic energy requirements for parking and includes:
  - **Lighting Energy.** Lighting is required for all parking areas, with power density and hours of operation that vary by the type of parking.
  - **Ventilation Energy.** Ventilation is required for fully enclosed parking structures that have no access to natural ventilation.
  - **Heating Energy.** Heating may be provided in enclosed parking garages in very cold climates.
- **Release Date.** The model is updated periodically as industry standards for design and operation are updated and as better engineering data becomes available:
  - Most Recent Update: August 2023
  - Previous Updates: August 2018, July 2013
  - Original Release: June 2001

This document presents details on how the ENERGY STAR score accounts for parking. More information on the overall approach to develop ENERGY STAR scores is covered in our Technical Reference for the ENERGY STAR Score, available at www.energystar.gov/ENERGYSTARscore.

The subsequent sections of this document offer specific details on the development of the parking model:

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THEORETICAL BACKGROUND

Energy use of a parking area may be composed of three main factors: energy required to provide adequate lighting, energy required for ventilation, and energy required for heating. The specific requirements for each of these components will depend on the type of parking (e.g., open parking lot, completely enclosed or underground garage, partially enclosed garage) and the location of the structure (very cold vs. mild climate). For each type, general assumptions and calculations can be made based on standard engineering design and safety principles.

Lighting Energy

The metric used for lighting energy consumption is lighting power density (i.e., watts per square foot). To determine appropriate assumptions, EPA referenced the ASHRAE Energy Standard for Buildings Except Low Rise Residential Buildings in addition to a review of existing building codes and local ordinances.[1] Based on these standard practices, the lighting densities listed below are assumed to be typical. Please note that the 2023 lighting adjustment is applicable immediately for all property types in Canada. The 2023 adjustment for U.S. scoring models will be phased in to coincide with more comprehensive model updates to limit disruption. Initially the 2023 adjustment will be applicable to the vehicle dealership score. Property types that will continue to utilize the 2018 adjustment until a more comprehensive model update is released include Data Centers, Hotels, K-12 Schools, Multifamily Housing, Offices, Residence Halls and Dormitories, Retail Stores and Supermarkets, Warehouses and Worship Facilities.

2023 Lighting Adjustment:

- Lighting power density for parking areas in completely enclosed and partially enclosed parking garages is assumed to be 0.11 watts per square foot. Additional lighting within the daylight transition zones for these garages is assumed to be 0.95 watts per square foot.[2]
- Lighting power density for open parking lots is assumed to be lower, at 0.037 watts per square foot.

2018 Lighting Adjustment:

- Lighting power density for completely enclosed and partially enclosed parking garages is assumed to be 0.30 watts per square foot.
- Lighting power density for open parking lots is assumed to be lower, at 0.15 watts per square foot.

In addition to lighting power density, it is also necessary to consider the length of time that lighting is required each day. Completely enclosed and partially enclosed parking garages are assumed to require 24 hours of lighting,[2] as no other sources of light are available. For 2023, open parking lots, which have direct access to natural light during the

[1] The City of Seattle Energy Code, for example, states that "the allowance for open parking and outdoor areas shall be 0.10 W/ft^2."

[2] ANSI/ASHRAE/IES Standard 90.1-2022 requires that (1) lighting power of each luminaire be automatically reduced by a minimum of 50% when there is no activity detected within a lighting zone for 10 minutes, (2) parking garage daylight transition zone lighting be separately controlled to automatically reduce the lighting to no more than the general light level from sunset to sunrise, and (3) the power to any luminaire within 20 feet of perimeter wall openings totaling at least 24 square feet be automatically reduced through continuous dimming in response to available daylight. For this adjustment EPA assumes that:

1. All general lighting in fully enclosed parking garages and 85% of general lighting in partially enclosed parking garages operates at full power for 18 hours per day and at 50% power for 6 hours each day.
2. 10% of total parking garage area is in a daylight transition zone.
3. 15% of general lighting in partially enclosed garages are within 20 feet of a wall opening totaling at least 24 square feet and operate at full power for 15 hours per day and at 50% power for 9 hours each day.

daytime, are assumed to require 12 hours of lighting[3] (16 hours of lighting was assumed for the 2018 lighting adjustment).

Ventilation Energy (2018 adjustment unchanged for 2023)

Completely enclosed parking garages that have no access to natural ventilation require mechanical ventilation to remove tailpipe emissions and ensure safety within the structure. Ventilation requirements are characterized in terms of air flow rate (i.e., cubic feet per minute per square foot, cfm/ft^2). A maximum ventilation rate of 1.0 cfm/ft^2 was assumed for calculations.[4]

In order to compute total annual energy use of a mechanical ventilation system, it is necessary to estimate its hours of operation. Current best practice in parking garage ventilation is to automatically adjust fan operation based on demand, and to run fans in setback mode when full power is not necessary. The model assumes that ventilation fans operate at full power for 6 hours per day and in setback mode (0.05 cfm/ft^2) for 18 hours per day.[5]

Ventilation is assumed to be unnecessary for partially enclosed parking garages and open parking lots, which have access to natural ventilation.

Heating Energy (2018 adjustment unchanged for 2023)

Heating is generally only utilized in completely enclosed parking garages in very cold climates. Heating is rare in most U.S. garages but is relatively common in Canada. If heating is present in a parking garage, Portfolio Manager includes adjustments to account for heating energy. The following assumptions are made:

- The primary heat load in parking garages is due to ventilation. Envelope loads are ignored.
- Ventilation fans operate as described in the previous section.
- The heating fuel is natural gas, and the heating system has an efficiency of 80%.
- The parking garage is heated to a temperature of 40 degrees Fahrenheit (4.4 degrees Celsius).

Given the space temperature of the garage, the energy estimates for heating are computed by multiplying the ventilation load by the heating degree days with a base of 40 degrees Fahrenheit.

PARKING ADJUSTMENT

Within Portfolio Manager, the engineering-based assumptions from the previous section are used to compute a parking adjustment for each parking space type within Portfolio Manager. ***Figures 1 and 2*** below show the power density and operating hours assumptions for the three parking space types, and the resulting predictions in units of site energy consumption.

[3] ANSI/ASHRAE/IES Standard 90.1-2022 requires luminaires mounted 25 feet or less above grade in parking lots to be controlled to reduce power by at least 50% when no activity is detected for not longer than 15 minutes. For this adjustment EPA assumes that open parking lot lighting operates at full power for 6 hours and at 50% power for 6 hours each day.
[4] ANSI/ASHRAE Standard 62.1 and the International Mechanical Code (ICC 2009a) allow 0.75 cfm/ft^2, while the National Fire Protection Association (NFPA) Standard 88A recommends a minimum of 1.0 cfm/ft^2.
[5] Assumptions for ventilation fan on-time and setback time are based on review of ASHRAE models for "car movement" profiles in parking garages. Assumptions for setback levels of ventilation are based on the 2009 International Mechanical Code, which states that the fans may be set back to 0.05 cfm/ft^2 when using demand control ventilation.

These site energy values are then multiplied by the applicable source-site ratios for the U.S. and Canada to determine the source energy adjustments for both countries.[6] The lighting and ventilation values are multiplied by the source-site ratio for electricity, and the heating values are multiplied by the source-site ratio for natural gas.

Figure 1A – 2023 Adjustments by Parking Type in Site Energy

Parking Type	End Use	Engineered Allowance *(W/ft²)*	Assumed Hours of Operation *(hours/day)*	Parking Area Site Energy (U.S.) *(kBtu/ft²/yr)*	Parking Area Site Energy (Canada) *(GJ/m²/yr)*
Open Parking	Lighting	0.037	12	0.4147	0.004710
Partially Enclosed Parking (No Walls)	General Lighting	0.11	24	4.266	0.04844
	Daylight Transition Zone Lighting	0.95	12		
Completely Enclosed Parking (Walls)	General Lighting	0.11	24	4.297	0.04879
	Daylight Transition Zone Lighting	0.95	12		
	Ventilation	0.29 (On)	6	2.391	0.02715
		0.01 (Setback)	18		
	Heating (If present)	0.009354 kBtu/ft²/yr/ $HDD_{Base40F}$	Based on Ventilation and Degree Days	0.009354 kBtu/ft²/yr/ $HDD_{Base40F}$	0.0001062 GJ/m²/yr/ $HDD_{Base4.4C}$

Figure 1B – 2018 Adjustments by Parking Type in Site Energy

Parking Type	End Use	Engineered Allowance *(W/ft²)*	Assumed Hours of Operation *(hours/day)*	Parking Area Site Energy (U.S.) *(kBtu/ft²/yr)*
Open Parking	Lighting	0.15	16	2.989
Partially Enclosed Parking (No Walls)	Lighting	0.30	24	8.968
Completely Enclosed Parking (Walls)	Lighting	0.30	24	8.968
	Ventilation	0.29 W/ft² (On)	6	2.391
		0.01 W/ft² (Setback)	18	
	Heating (If present)	0.009354 kBtu/ft²/yr/ $HDD_{Base40F}$	Based on Ventilation and Degree Days	0.009354 kBtu/ft²/yr/ $HDD_{Base40F}$

[6] https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf details the current ratios used in Portfolio Manager for properties in the U.S. and Canada to convert site energy to source energy.

The adjustments presented in ***Figures 1A or 1B*** can be used to estimate the total annual source energy across all parking space types. For example, the equation for an Auto Dealership in the United States with open parking, and partially enclosed parking, and completely enclosed and heated parking using the 2023 adjustments is:

Predicted Parking Source Energy (kBtu/yr)

= 0.4147 x (Area of Open Parking) x source-site ratio for electricity[6]
+ 4.266 x (Area of Partially Enclosed Parking) x source-site ratio for electricity[6]
+ (4.297 + 2.391) x (Area of Completely Enclosed Parking) x source-site ratio for electricity[6]
+ 0.009354 x $HDD_{Base40F}$ x (Area of Completely Enclosed and Heated Parking) x source-site ratio for natural gas[6]

The ENERGY STAR score for the U.S. is developed using units of kBtu for energy, while the ENERGY STAR score for Canada is developed using units of gigajoules (GJ) for energy. While the calculations within Portfolio Manager occur in different units, ultimately the results for the any property (U.S. or Canadian) can be displayed in Portfolio Manager in either kBtu or GJ.

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 an office with parking in the United States using the 2018 adjustments:

1 User enters building data into Portfolio Manager

- 12 months of energy use information for all energy types (annual values, entered in monthly meter entries)
- Physical building information (size, location, etc.) and use details describing building activity (hours, etc.)

Energy Data	Value
Electricity	3,500,000 kWh
Natural gas	4,000 therms

Office Property Use Details	Value
Gross floor area (ft^2)	200,000
Weekly operating hours	80
Workers on the main shift[7]	300
Number of computers	300
Percent of the building that is cooled	100%
HDD (provided by Portfolio Manager, based on Zip code)	4937
CDD (provided by Portfolio Manager, based on Zip code)	1046

Parking Use Details	Value
Open Parking Lot Size (ft^2)	10,000
Partially Enclosed Parking Garage Size (ft^2)	20,000
Completely Enclosed Parking Garage Size (ft^2)	30,000
Supplemental Heating	No

[7] This represents typical peak staffing level during the main shift. For example, in an office if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.

2 Portfolio Manager computes the actual source EUI

- Compute Billed Source Energy.
  - Total energy consumption for each fuel is converted from billing units into site and source energy.
  - Source energy values are added across all fuel types.

Fuel	Billing Units	Site kBtu Multiplier	Site kBtu	Source kBtu Multiplier	Source kBtu
Electricity	3,500,000 kWh	3.412	11,942,000	2.80	33,437,600
Natural gas	4,000 therms	100	400,000	1.05	420,000
				Total Source Energy (kBtu)	33,857,600

- Determine Predicted Parking Energy.

Predicted Parking Source Energy (kBtu/yr)
= 2.989 × (10,000) × 2.8
+ 8.967 × (20,000) × 2.8
+ 11.357 × (30,000) × 2.8
+ 0
= 1,539,832 kBtu

- Compute Actual Source Energy for the purposes of the ENERGY STAR score (equal to billed source energy minus predicted parking source energy).
  - 33,857,600 – 1,539,832
  - **Actual Source Energy = 32,317,768 kBtu**

- Compute Actual Source EUI (equal to actual source energy divided by total floor area).
  - 32,317,768 kBtu / 200,000 ft^2
  - **Actual Source EUI = 161.6 kBtu/ft^2**

3 Portfolio Manager computes the predicted source EUI

- Using the property use details from Step 1, Portfolio Manager computes each building variable value in the regression equation (determining the natural log or density, or applying any minimum values used in the regression model, 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 regression equation to obtain a predicted source EUI.

Computing Predicted Source EUI

Variable	Actual Building Value	Reference Centering Value	Building Centered Variable	Coefficient	Coefficient * Centered Variable
Constant	--	--	--	143.1	143.1
Square Foot (*max value of 100,000*)	100,000	12,342	87,658	0.0006768	59.33
Weekly Operating Hours	80	54.09	25.91	0.6130	15.88
Number of Workers per 1,000 ft²	1.500	2.056	-0.5560	15.90	-8.840
Number of Computers per 1,000 ft²	1.500	3.028	-1.528	10.13	-15.48
Percent Cooled × Ln (Cooling Degree Days)	6.953	6.332	0.6210	4.529	2.813
Small Bank	0.0000	NA	0.0000	82.87	0.0000
Heating Degree Days	4937	924	4013	0.004693	18.83
				Predicted Source EUI (kBtu/ft²)	**215.6**

4 Portfolio Manager computes the energy efficiency ratio

- The ratio equals the actual source EUI (Step 2) divided by predicted source EUI (Step 3)
- Energy Efficiency Ratio = 161.6 / 215.6 = 0.7495

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 for offices.
- A ratio of 0.7495 is greater than or equal to 0.7406 and less than 0.7511.
- ***The ENERGY STAR score is 61.***