ENERGY STAR

Portfolio Manager 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, taking into account the 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 (i.e., office 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.** An engineered model is developed to estimate the energy use for parking. This estimated energy use is subtracted from the building's actual energy use, yielding 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 will be incorporated into the ENERGY STAR score for eligible property types. This includes open parking lots, completely enclosed parking garages (walls on all sides), and partially enclosed parking garages. If parking space 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 model is based on engineered assumptions regarding basic energy requirements for parking that 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: July 2013
    - Previous Update: October 2007
    - 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:

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 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

Lighting requirements are typically described in terms of lighting power density (i.e., watts per square foot). To determine appropriate assumptions, EPA referenced ASHRAE Energy Standard for Buildings Except Low Rise Residential Building in addition to a review of existing building codes and local ordinances.[1] Based on these standard practices, the following lighting densities are assumed to by typical:

- 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 consideration of the lighting power density, it is also necessary to account for the hours of the day during which lighting will be required. Completely enclosed and partially enclosed parking garages are assumed to require 24 hours of lighting, as no other sources of light are available. Open parking lots, which have direct access to natural light during the daytime, are assumed to only require 16 hours of lighting.

Ventilation

Ventilation is required for completely enclosed parking garages that have no access to natural ventilation. Ventilation is used to remove tailpipe emissions and ensure safety within the structure. Ventilation requirements are characterized in terms of a flow rate (e.g. cubic feet per minute per square foot, cfm/ft^2). A ventilation rate of 1.0 cfm/ft^2 was assumed for calculations.[2] This rate translates to fan power of 0.39 horsepower per 1,000 square feet.[3]

In order to compute the ventilation requirement over the year, it is necessary to understand the hours of operation for the ventilation fans. Current best practice in parking garage operation is to automatically adjust fan operation based on demand, and to run fans in setback mode when full power is not necessary. Therefore, the model assumes that the fans are operating at full power for 6 hours per day, and are in setback mode (0.05 cfm/ft^2) for 18 hours per day.[4]

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

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[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 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.

[3] Fan hp = (CFM x Static Pressure) / (6356 * Motor-Fan Eff). Ventilation system static pressure is assumed to be 1.6 in WC, and fan efficiency is assumed to be 65%, based on values included in the Parking Garage Ventilation Guide published by Air Test Technologies.

[4] 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.

Heating

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.

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 within Portfolio Manager. ***Figure 1*** below shows the power density (W/ft^2 and horsepower/1000 ft^2) and operating hours assumptions for the three parking space types, and the resulting predictions in units of site energy. These site energy values are then multiplied by the source-site ratios for the U.S. and Canada to determine the source energy adjustments for both countries. 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 2*** presents the resulting source energy values.

Figure 1 – Adjustments by Parking Type in Site Energy

Parking Type	End Use	Engineered Allowance	Assumed Hours of Operation	Parking Area Site Energy
Open Parking	Lighting	0.15 W/ft^2	16 Hours/day	2.989 kBtu/ft^2/yr
Partially Enclosed Parking (No Walls)	Lighting	0.30 W/ft^2	24 Hours/day	8.967 kBtu/ft^2/yr
Completely Enclosed Parking (Walls)	Lighting	0.30 W/ft^2	24 Hours/day	8.967 kBtu/ft^2/yr
	Ventilation	0.29 W/ft^2 (On)	6 Hours/day	2.39 kBtu/ft^2/yr
		0.01 W/ft^2 (Setback)	18 Hours/day	
	Heating (if present)	0.009354 kBtu/ft^2/yr/ $HDD_{Base40F}$	Based on Ventilation and Degree Days	0.009354 kBtu/ft^2/yr/ $HDD_{Base40F}$

Figure 2 – Adjustments by Parking Type in Source Energy

Parking Type	End Use	Parking Source Energy U.S.	Parking Source Energy Canada
Open Parking	Lighting	9.385 kBtu/ft^2/yr	6.128 kBtu/ft^2/yr
Partially Enclosed Parking (No Walls)	Lighting	28.16 kBtu/ft^2/yr	18.38 kBtu/ft^2/yr
Completely Enclosed Parking (Walls)	Lighting	28.16 kBtu/ft^2/yr	18.38 kBtu/ft^2/yr
	Ventilation	7.51 kBtu/ft^2/yr	4.902 kBtu/ft^2/yr
	Heating (if present)	0.009822 kBtu/ft^2/yr/ $HDD_{Base40F}$	0.009451 kBtu/ft^2/yr/ $HDD_{Base40F}$

The adjustments presented in ***Figure 2*** can be combined into one equation to estimate the total annual source energy across all parking spaces. For example, the equation for the United States is:

Predicted Parking Source Energy (kBtu/yr)

= 9.385*(Area of Open Parking)
+ 28.16*(Area of Partially Enclosed Parking)
+ 35.67*(Area of Completely Enclosed Parking)
+ 0.009822 * $HDD_{Base40F}$ * (Area of Completely Enclosed Parking – if heated)

Note that the parking energy adjustments in ***Figure 2*** are presented in units of kBtu. 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. The parking energy adjustments for Canada can be converted to GJ using standard thermal conversion factors, available in our Technical Reference for Thermal Energy Conversions, at www.energystar.gov/ThermalConversions. In addition to the conversion from kBtu to GJ, it is also necessary to account for the conversion from degree days in Fahrenheit to Celsius. In order to do this, the coefficient for this term can be multiplied by 9/5. 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:

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[5]	250
Number of personal computers	250
Percent of the building that is heated	100 %
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

2 Portfolio Manager computes the actual source EUI

- Billed Source Energy is computed
  - 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	3.14	37,497,880
Natural gas	4,000 therms	100	400,000	1.05	420,000
				Total Source Energy (kBtu)	37,917,880

[5] 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.

- Predicted Parking Energy is determined

  Predicted Parking Source Energy (kBtu/yr)
  = 9.385*(10,000)
  + 28.16*(20,000)
  + 35.67*(30,000)
  + 0.009822 * HDD * (0)
  = 1,727,150 kBtu

- Actual Source energy for the purposes of the ENERGY STAR score is equal to billed source energy minus predicted parking energy
  - The predicted energy for the parking is subtracted to enable a score for the office only.
  - 37,917,880 – 1,727,150 = 36,190,730 kBtu Source

- Actual Source EUI is equal to source energy divided by total floor area
  - 36,190,730 kBtu / 200,000 ft^2
  - **Actual Source EUI = 181.0 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 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	--	--	--	186.6	186.6
Ln (Square Foot)	12.21	9.535	2.675	34.17	91.40
Number of Computers per 1000 ft^2	1.250	2.231	-0.9810	17.28	-16.95
Ln (Weekly Operating Hours)	4.382	3.972	0.4100	55.96	22.94
Ln (Number of Workers per 1000 ft^2)	0.2230	0.5616	-0.3386	10.34	-3.501
HDD x Percent Heated	4937	4411	526.0	0.0077	4.050
CDD x Percent Cooled	1046	1157	-111.0	0.0144	-1.598
Small Bank x Ln (Square Foot)	0.0000	NA	0.0000	-64.83	0.0000
Small Bank x Ln (Number of Workers per 1000 ft^2)	0.0000	NA	0.0000	34.20	0.0000
Small Bank	0.0000	NA	0.0000	56.30	0.0000
			Predicted Source EUI (kBtu/ft^2)		**282.9**

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 = 181.0 / 282.9 = 0.6396

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 0.6396 is greater than or equal to 0.6332 and less than 0.6429.
- ***The ENERGY STAR score is 76.***