

# OP 5: Building Energy Efficiency

6 points available

## Rationale

This credit recognizes institutions that are improving the energy efficiency of their buildings.

## Applicability

This credit applies to all institutions.

## Criteria

### Part 1. Site energy use per unit of floor area

Institution's annual *site energy* consumption is less than the *minimum performance threshold* of 389 Btu per gross square metre per Celsius *degree day* (65 Btu per gross square foot per Fahrenheit degree day).

Performance for Part 1 of this credit is assessed using *EUI-adjusted floor area*, a figure that accounts for significant differences in energy use intensity (EUI) between types of building space.

### Part 2. Reduction in source energy use per unit of floor area

Institution has reduced its total *source energy* consumption per gross square metre or foot of floor area compared to a baseline.

## Scoring

Each part is scored independently. Points earned are calculated according to the formulas below. Please note that users do not have to calculate the number of points earned themselves; points will be calculated automatically when the data listed under Reporting Fields is entered in the online Reporting Tool.

### Part 1

An institution earns the maximum of 3 points available for Part 1 when its total annual energy consumption is 90 percent or more below the minimum performance threshold of 389 Btu (0.000389 MMBtu) per gross square metre per Celsius degree day (0.000065 MMBtu per gross square foot per Fahrenheit degree day).

Incremental points are awarded based on the institution's performance below the threshold. For example, an institution whose total annual energy consumption per gross square foot per Fahrenheit degree day is 35.75 Btu (i.e., 45 percent below the 65 Btu threshold) would earn 1.5 points (half of the points available for Part 2).

Scoring for Part 1 of this credit is based on site energy and EUI-adjusted floor area. The STARS Reporting Tool calculates EUI-adjusted floor area according to the following formula:

$$\text{EUI-adjusted floor area} = \{ A + [ 2 \times ( B + C ) ] + D \}$$

A = Gross floor area of building space (square metres or feet)

B = Floor area of laboratory space (square metres or feet)

C = Floor area of healthcare space (square metres or feet)

D = Floor area of other energy intensive space (square metres or feet)

The Reporting Tool calculates total energy consumption (site energy) according to the following formula:

$$\text{Total energy consumption (site energy), performance year} = [ ( A + B ) \times 0.003412 ] + C + D$$

A = Imported electricity, performance year (kWh)

B = Electricity from on-site, non-combustion facilities/devices (e.g., renewable energy systems), performance year (kWh)

C = Stationary fuels used on-site to generate electricity and/or thermal energy, performance year (MMBtu)

D = Imported steam, hot water, and/or chilled water, performance year (MMBtu)

Points earned for Part 1 of this credit are then calculated according to the following formula:

$$\text{Points earned for Part 1} = 3\frac{1}{3} \times \{ [ A - ( B / C ) / D ] / A \}$$

A = Minimum performance threshold (in MMBtu per square metre or foot per degree day)

B = Total energy consumption (site energy), performance year (MMBtu)

C = EUI-adjusted floor area, performance year (square metres or feet)

D = Total degree days, performance year (heating + cooling)

## Part 2

An institution earns the maximum of 3 points available for Part 2 of this credit by reducing its total energy consumption per gross square metre/foot of floor area by 50 percent compared to a baseline. Partial points are awarded based on the reduction achieved. For example, an institution that reduced its total energy consumption per gross square metre/foot of floor area by 25 percent would earn 1.5 points (half of the points available for Part 2 of this credit).

Scoring for Part 2 is based on source energy, a figure that accounts for the energy used off-site to generate and transport imported electricity to the institution. For scoring purposes, imported electricity is converted to source energy through the use of an appropriate *source-site ratio*.

The STARS Reporting Tool calculates total energy consumption (source energy) according to the following formula:

$$\text{Total energy consumption (source energy)} = \{ [ ( A \times B ) + C ] \times 0.003412 \} + D + E$$

A = Imported electricity (kWh)

B = Source-site ratio for grid-purchased electricity

C = Electricity from on-site, non-combustion facilities/devices (e.g., renewable energy systems) (kWh)

D = Stationary fuels used on-site to generate electricity and/or thermal energy (MMBtu)

E = Imported steam, hot water, and/or chilled water (MMBtu)

Points earned for Part 2 of this credit are calculated according to the formula below. STARS awards only positive points; points will not be deducted if total energy consumption per gross square metre/foot of floor area increased rather than decreased during the time period.

$$\text{Points earned for Part 2} = 6 \times \{ [(A/B) - (C/D)] / (A/B) \}$$

A = Total energy consumption (source energy), baseline year (MMBtu)

B = Gross floor area of building space, baseline year (gross square metres or feet)

C = Total energy consumption (source energy), performance year (MMBtu)

D = Gross floor area of building space, performance year (gross square metres or feet)

## Reporting Fields

### Required

#### Part 1

- Figures needed to determine total energy consumption during the performance year:
  - Electricity (in kilowatt-hours):
    - Imported electricity, performance year (kWh)
    - Electricity from on-site, non-combustion facilities/devices (e.g., renewable energy systems), performance year (kWh)
  - Stationary fuels and thermal energy (in millions of British thermal units):
    - Stationary fuels used on-site to generate electricity and/or thermal energy, performance year (MMBtu)
    - Imported steam, hot water, and/or chilled water, performance year (MMBtu)
- *Gross floor area of building space*, performance year (gross square metres or feet)
- Floor area of *laboratory space*, performance year (square metres or feet)
- Floor area of *healthcare space*, performance year (square metres or feet)
- Floor area of other *energy intensive space*, performance year (square metres or feet)
- Heating degree days, performance year (°C or °F)
- Cooling degree days, performance year (°C or °F)
- Start date, performance year or 3-year period
- End date, performance year or 3-year period

#### Part 2

- Figures needed to determine total energy consumption during the baseline year:
  - Electricity (in kilowatt-hours):
    - Imported electricity, baseline year (kWh)
    - Electricity from on-site, non-combustion facilities/devices (e.g., renewable energy systems), performance year (kWh)
  - Stationary fuels and thermal energy (in millions of British thermal units):
    - Stationary fuels used on-site to generate electricity and/or thermal energy, baseline year (MMBtu)

- Imported steam, hot water, and/or chilled water, baseline year (MMBtu)
  - Gross floor area of building space, baseline year (gross square metres or feet)
  - Start date, baseline year or 3-year period
  - End date, baseline year or 3-year period
- If end date of the baseline year/period is 2004 or earlier, provide:
- A brief description of when and why the energy consumption baseline was adopted (e.g., in sustainability plans and policies or in the context of other reporting obligations)
  - Source-site ratio for imported electricity (see Measurement)

### Optional

- Documentation (e.g. spreadsheet or utility records) to support the performance year energy consumption figures reported above (upload)
- A brief description of any of the following energy conservation and efficiency technologies or strategies employed by the institution:
  - Initiatives to shift individual attitudes and practices in regard to energy efficiency (e.g., outreach and education efforts)
  - Energy use standards and controls (e.g., building temperature standards, occupancy and vacancy sensors)
  - Light Emitting Diode (LED) lighting and other energy-efficient lighting strategies
  - Passive solar heating, geothermal systems, and related strategies
  - Co-generation, e.g. combined heat and power (CHP)
  - Initiatives to replace energy-consuming appliances, equipment and systems with high efficiency alternatives (e.g., building re-commissioning or retrofit programs)
- Website URL where information about the institution's energy conservation and efficiency program is available
- Additional documentation to support the submission (upload)
- Data source(s) and notes about the submission
- Contact information for a responsible party (an employee who can respond to questions regarding the data once it is submitted and available to the public)

## Measurement

### Timeframe

#### Performance Year

Report the most recent data available from the three years prior to the anticipated date of submission. Institutions may use the most recent single year for which data is available or an average from throughout the period. Institutions may choose the annual start and end dates that work best with the data they have (e.g., fiscal or calendar year), as long as data are reported from a consecutive 12-month (or 3-year) period.

Report degree day and building space figures from the same time period as that from which energy consumption data are drawn (e.g., the consecutive 12-month or 3-year period that most closely overlaps with the building energy consumption performance period). Institutions may use average building space from throughout the period or a snapshot at a single representative point during the period.

## Baseline Year

Report data from the baseline year, which may be:

- Any year from 2005 to the present
- A baseline year, 1990 to 2004, that the institution has adopted as part of its sustainability plans or policies or in the context of other reporting obligations

Recommended best practices for defining a baseline include:

- Using the average of three consecutive years to reduce the impact of outliers.
- Using the same baseline year for multiple credits to reduce reporting requirements. For example, institutions using 2005 for all STARS credits that are baseline-based would only have to calculate baseline weighted campus user data once.
- Ensuring that baseline and performance year data are valid and reliable (e.g., that the data were gathered in the same manner)

Institutions without valid and reliable historical data should use performance year data for both the baseline and performance year. Following this approach, an institution would not be able to claim points for reductions during its first STARS submission, but would be able to use its newly established baseline for subsequent submissions.

Institutions may choose the start and end dates that work best with the data they have (e.g., fiscal or calendar year), as long as data are reported from a consecutive 12-month (or 3-year) period.

Report degree day and building space data from the same period as that from which energy consumption data are drawn (e.g., the consecutive 12-month or 3-year period that most closely overlaps with the building energy consumption baseline period). Institutions may use average building space from throughout the period or a snapshot at a single representative point during the period.

## Sampling and Data Standards

Include all building energy consumption, i.e., all electricity, stationary fuels, and other energy products used on-site by the institution (as the institution is defined in the overall STARS institutional boundary). Transportation fuels are excluded. Reporting on a sample or subset of buildings is not allowed for this credit.

Institutions that convert fuel on-site (e.g., on-campus cogeneration facilities and boilers) should report only the amount of fuel purchased/converted toward the total energy consumption figure, not the resulting heat, steam, hot/chilled water or electricity.

All reported energy consumption figures should be based on site energy (the amount of energy consumed by campus buildings) rather than source energy (the amount of energy consumed on campus plus the energy used off-site to generate and transport the energy to the institution). Source energy will be calculated automatically when the data listed under Reporting Fields is entered in the online Reporting Tool.

Consistent with U.S. EPA Portfolio Manager and published national and regional averages, the following default source-site ratios (i.e., primary energy factors) for imported electricity are used:

U.S.	Canada	Europe	All other
3.0	2.0	2.0	2.5

Institutions located outside the U.S. and Canada that have available national or regional primary energy factors (PEFs) for imported electricity may report those figures in lieu of the above and should document the source of the data in “Data source(s) and notes about the submission”. Please note that PEFs should be calculated on the basis that the PEF for on-site renewable energy equals 1 (as opposed to zero).

To simplify reporting, a single source-site ratio for imported electricity is used for both the performance year and the baseline year, and stationary fuels and imported thermal energy, which have lower and more locally variable distribution losses than electricity, are treated as site energy.

MMBtu (one million British thermal units - a standard measure of energy) is used to aggregate energy consumption data from multiple sources. An institution must report electricity data in kilowatt-hours, which are converted to MMBtu automatically in the Reporting Tool using a factor of 0.003412. All other figures (i.e., for stationary fuels and thermal energy) must be converted into MMBtu using the following equivalents prior to being entered into the Reporting Tool:

Energy unit	MMBtu equivalent
1 therm	0.1
1 kBtu	0.001
1 ton-hour	0.012
1 MJ	0.000948

AASHE publishes a [unit conversion tool](#) that includes more detailed conversion factors (e.g., for liquid fuels). See also the International Energy Agency’s [unit converter](#).

To simplify reporting, heating and cooling degree day data should use a single base temperature for the institution’s main campus location. Base temperature is the temperature below which the institution’s buildings require heating and above which the buildings require cooling. For U.S. and Canadian institutions, this is typically 65 °F (18 °C). Degree day data may be downloaded from [DegreeDays.net](#) (global data), [ENERGY STAR Portfolio Manager](#) (U.S. and Canada), or another source of national or international weather data.

## Standards and Terms

### Degree day

Degree days are a representation of outside air-temperature data widely used to normalize the effect of outside air temperature on building energy consumption. According to [Degree Days.net](#):

"Heating degree days", or "HDD", are a measure of how much (in degrees), and for how long (in days), outside air temperature was lower than a specific "base temperature" (or "balance point"). They are used for calculations relating to the energy consumption required to heat buildings.

"Cooling degree days", or "CDD", are a measure of how much (in degrees), and for how long (in days), outside air temperature was higher than a specific base temperature. They are used for calculations relating to the energy consumption required to cool buildings.

### **Energy intensive space**

Energy intensive space includes "laboratory space", "healthcare space", and "other energy intensive space", which is reported separately and may include restaurants and food production facilities, convenience and grocery stores, and data centers.

Other facilities that the institution has determined to have an average energy use intensity (EUI) that is at least twice that of office/administrative space may also be counted as "other energy intensive space", however classrooms, offices, residence halls, auditoriums, gymnasiums, arenas/stadiums, clinics, storage facilities, and convention centers would NOT typically qualify.

Energy use intensity is a unit of measurement that represents the energy consumed by a building relative to its size, e.g., 1,000 MMBtu per square metre. For more information, see ENERGY STAR Portfolio Manager Technical Reference: U.S. Energy Use Intensity by Property Type.

### **EUI-adjusted floor area**

EUI-adjusted floor area is a figure that adjusts each institution's actual floor area to account for significant differences in energy use intensity (EUI) between types of building space. Energy use intensity is a unit of measurement that represents the energy consumed by a building relative to its size, for example 1,000 MMBtu per square metre.

STARS calculates the figure according to the following formula. Please note that users will not have to calculate this figure themselves; the result will be calculated automatically when data are entered into the online Reporting Tool.

$$\text{EUI-adjusted floor area} = \{ A + [ 2 \times ( B + C ) ] + D \}$$

A = Gross floor area of building space (square metres or feet)

B = Floor area of laboratory space (square metres or feet)

C = Floor area of healthcare space (square metres or feet)

D = Floor area of other energy intensive space (square metres or feet)

### **Gross floor area of building space**

Gross floor area of building space refers to the total amount of building space that is included within the institutional boundary. Any standard definition of building space may be used (e.g., ASHRAE, ANSI/BOMA, IECC) as long as it is used consistently. Parking structures are included. For guidance on calculating gross square footage of a building, you may also consult 3.2.1 Gross Area of the U.S. Department of Education's Postsecondary Education Facilities Inventory and Classification Manual.

Buildings within the overall STARS boundary that the institution leases entirely (i.e., the institution is the only tenant) should be included.

Buildings that are not owned by the institution and in which the institution is one of multiple tenants may be excluded. If the institution chooses to include such buildings, it must include all multi-tenant buildings that are included in the institution's overall STARS boundary and in which the institution is a tenant; institutions cannot choose to include some leased spaces and omit others. If an institution chooses to include leased spaces, the institution should count only the square footage of building space it occupies and not the entire building.

### **Healthcare space**

The total amount of building space within the institutional boundary that may be categorized as "Health Care Facilities" (e.g., codes in the 800 series under the Space Use Codes in the U.S. Department of Education's Postsecondary Education Facilities Inventory and Classification Manual). To simplify reporting, institutions with hospitals may report all floor area within hospitals as healthcare space.

### **Imported electricity**

Imported electricity includes all electricity purchased or otherwise obtained from off-campus sources.

### **Laboratory space**

The total amount of building space within the institutional boundary that may be categorized as "research laboratories" (e.g., code 250 under the Space Use Codes in the U.S. Department of Education's Postsecondary Education Facilities Inventory and Classification Manual). To simplify reporting, institutions may report all floor area within buildings that contain research laboratories as laboratory space.

### **Minimum performance threshold**

Minimum performance thresholds are benchmarks against which campus performance may be assessed for scoring purposes. The thresholds used in this version of STARS were calculated at the first decile for institutions reporting under STARS 2.0 as of July 31, 2015 and rounded to the nearest hundredth. In other words, 90 percent of institutions rated under STARS 2.0 before July 31, 2015 performed better than the minimum threshold. Extreme outliers were excluded from the calculations.

### **Site energy**

Consistent with U.S. EPA Portfolio Manager, site energy is defined as:

...the amount of heat and electricity consumed by a building as reflected in utility bills. Site energy may be delivered to a facility in one of two forms. Primary energy is the raw fuel that is burned to create heat and electricity, such as natural gas or fuel oil. Secondary energy is the energy product created from a raw fuel, such as electricity purchased from the grid or heat received from a district steam system.

### **Source energy**

According to U.S. EPA Portfolio Manager:

A unit of primary energy and a unit of secondary energy consumed at the site are not directly comparable because one represents a raw fuel while the other represents a converted fuel. Ultimately, buildings require heat and electricity to operate, and there are always losses associated with generating and delivering this heat and electricity. Source energy traces the heat and electricity requirements of the building back to the raw fuel input, thereby accounting for any losses and enabling a complete thermodynamic assessment.

### **Source-site ratio**



Also known as "primary energy factor (PEF)", the U.S. Environmental Protection Agency (EPA) defines source-site ratio in the following way:

Most building managers are familiar with site energy, the amount of heat and electricity consumed by a building as reflected in utility bills. Site energy may be delivered to a facility in one of two forms: primary and/or secondary energy. Primary energy is the raw fuel that is burned to create heat and electricity, such as natural gas or fuel oil used in onsite generation. Secondary energy is the energy product (heat or electricity) created from a raw fuel, such as electricity purchased from the grid or heat received from a district steam system. A unit of primary and a unit of secondary energy consumed at the site are not directly comparable because one represents a raw fuel while the other represents a converted fuel. Therefore, in order to assess the relative efficiencies of buildings with varying proportions of primary and secondary energy consumption, it is necessary to convert these two types of energy into equivalent units of raw fuel consumed to generate that one unit of energy consumed on-site. To achieve this equivalency, EPA uses the convention of source energy.

When primary energy is consumed on site, the conversion to source energy must account for losses that are incurred in the storage, transport and delivery of fuel to the building. When secondary energy is consumed on site, the conversion must account for losses incurred in the production, transmission, and delivery to the site. The factors used to restate primary and secondary energy in terms of the total equivalent source energy units are called the source-site ratios.

## Scoring Example: Building Energy Consumption

The following data describe Example University (U.S.):

Imported electricity, performance year = 100,000 MMBtu

Electricity from on-site, non-combustion facilities/devices, performance year = 30,000 MMBtu

Stationary fuels used on-site to generate electricity and/or thermal energy, performance year = 40,000 MMBtu

Imported steam, hot water, and/or chilled water, performance year = 0 MMBtu

Gross floor area of building space, performance year = 2,500,000 square feet

Total degree days (HDD + CDD), performance year = 6,000 degree-days (°F)

Imported electricity, baseline year = 100,000 MMBtu

Electricity from on-site, non-combustion facilities/devices, baseline year = 0 kWh

Stationary fuels used on-site to generate electricity and/or thermal energy, baseline year = 60,000 MMBtu

Imported steam, hot water, and/or chilled water = 0 MMBtu

Gross floor area of building space, baseline year = 2,000,000 square feet

### Part 1

EUI-adjusted floor area

- A. Gross floor area of building space, performance year = 2,500,000 square feet
- B. Floor area of laboratory space, performance year = 200,000 square feet
- C. Floor area of healthcare space, performance year = 0
- D. Floor area of other energy intensive space, performance year = 100,000 square feet

$$\begin{aligned}\text{EUI-adjusted floor area} &= \{ A + [ 2 \times ( B + C ) ] + D \} \\ &= \{ 2,500,000 + [ 2 \times ( 200,000 + 0 ) ] + 100,000 \} \\ &= \{ 2,500,000 + [ 2 \times ( 200,000 ) ] + 100,000 \} \\ &= 2,500,000 + 400,000 + 100,000 \\ &= 3,000,000 \text{ square feet}\end{aligned}$$

Points earned for Part 1

- a. Minimum performance threshold = 65 Btu (0.000065 MMBtu) per square foot per degree day
- b. Total energy consumption, performance year = 170,000 MMBtu
- c. EUI-adjusted floor area, performance year = 3,000,000 square feet
- d. Total degree days (HDD + CDD), performance year = 6,000

$$\begin{aligned}\text{Points earned} &= 3\frac{1}{3} \times \{ [ ( a ) - ( b / c ) / d ] / a \} \\ &= 3\frac{1}{3} \times \{ [ ( .000065 ) - ( b / c ) / d ] / .000065 \} \\ &= 3\frac{1}{3} \times \{ [ ( .000065 ) - ( 170,000 / 3,000,000 ) / 6,000 ] / ( .000065 ) \} \\ &= 3\frac{1}{3} \times \{ [ .000065 - ( .0567 / 6,000 ) ] / .000065 \} \\ &= 3\frac{1}{3} \times [ ( .000065 - .0000094 ) / .000065 ] \\ &= 3\frac{1}{3} \times ( .0000556 / .000065 ) = 2.85 \text{ points}\end{aligned}$$

Total points earned

$$= 1.067 + 2.85$$

$$= 3.92 \text{ points}$$

## Part 2

Source energy

$$\text{Total building energy consumption (source energy)} = (A \times B) + C + D + E$$

A = Imported electricity (kWh)

B = Source-site ratio for imported electricity (3)

C = Electricity from on-site, non-combustion facilities/devices renewables (kWh)

D = Stationary fuels used on-site to generate electricity and/or thermal energy (MMBtu)

E = Imported steam, hot water, and/or chilled water (MMBtu)

Points earned for Part 2

- a. Total energy consumption (source energy), baseline year = 360,000 MMBtu  
[ ( 100,000 MMBtu imported electricity  $\times$  3 ) + 60,000 MMBtu from other sources ]
- b. Gross floor area of building space, baseline year = 2,000,000 square feet
- c. Total energy consumption (source energy), performance year = 370,000 MMBtu [ ( 100,000 MMBtu imported electricity  $\times$  3 ) + 70,000 MMBtu from other sources ]
- d. Gross floor area of building space, performance year = 2,500,000 square feet

$$\text{Points earned} = 6 \times \{ [ (a / b) - (c / d) ] / (a / b) \}$$

$$= 6 \times \{ [ ( 360,000 / 2,000,000 ) - ( 370,000 / 2,500,000 ) ] / ( 360,000 / 2,000,000 ) \}$$

$$= 6 \times [ ( 0.18 - 0.148 ) / 0.18 ]$$

$$= 6 \times ( 0.032 / 0.18 )$$

$$= 6 \times 0.178 = 1.067 \text{ points}$$